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A REVIEW

OF

MINING OPERATIONS

IN THE

STATE OF SOUTH AUSTRALIA

DURING THE

HALF-YEAR ENDED DECEMBER 31st, 1913.

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COMPILED, AND ISSUED UNDER THE AUTHORITY OF THE

HONORABLE SIR RICHARD BUTLER, M.P.,

Minister of Mines,

By LIONEL C. E. GEE, Acting Secretary for Mines.

DEPARTMENT OF GEOLOGICAL SCIENCES,
UNIVERSITY OF TORONTO

Adelaide:

R. E. E. ROGERS, GOVERNMENT PRINTER, NORTH TERRACE.

1914.

To face page 1.

Mintaro Slate.

South Australia.

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Miners' Rights and Privileges thereunder.

A miner's right is obtainable at the Department of Mines, Adelaide, also at the issuing stations in the various mining districts, at a cost of 5s.

A miner's right is in force for one year from the date of issue, and may be renewed at any time during its currency for another term of one year on payment of 5s.

The holder of a miner's right is authorised to prospect on any mineral lands for any metal, mineral, coal, or oil, and to peg out (of the prescribed shape and dimensions) gold, mineral, coal, and oil claims, and also leases of a like nature.

AREAS AND WORKING CONDITIONS.

GOLD LEASES—Maximum area, 20 acres; working conditions, one man to every five acres.

MINERAL LEASES—40 acres; one man to every 10 acres.

MISCELLANEOUS LEASES—

Salt	640 acres;	special conditions.
Gypsum	640 "	"
Mining Works	10 "	one man.
COAL OR OIL LEASES	640 "	one man to every 40 acres.
GOLD DREDGING LEASES	200 "	special conditions.
MINERAL CLAIMS	40 "	
GOLD CLAIMS	30ft. x 30ft., alluvial;	100ft. x 600ft., reef.

Gold claims must be constantly worked—one man for each claim—and mineral claimholders must employ two men for each claim. Amalgamation of either gold or mineral claims reduces the labor conditions by one-half.

Gold, mineral, coal, and oil leases are granted for a term of 42 years—the two former at a rental of 1s. per acre per annum and a royalty of 6d. in the pound on net profits, the latter at a rental of 6d. per acre per annum until coal or oil is found in payable quantities, when 1s. per acre is payable and a royalty of 6d. in the pound on the net profits.

The Minister may permit, for the concentration of labor, of the amalgamation of not more than four adjoining gold or mineral leases.

Any number of gold, mineral, coal, or oil leases may be held by one person.

Licences to search for twelve months for precious stones, mineral phosphates, oil, rare metals, minerals, and earths are issued on specific mineral lands, not exceeding five square miles in area for one person, a fee of 20s. being charged for each square mile or portion thereof. These licences give a preferential right to a lease over a portion of the area, as prescribed.

PREFACE.

THE value of the total production of Metals and Minerals, so far as can be ascertained, for the Year 1913 exceeds that of 1912 by nearly £47,000.

Copper has continued at a satisfactory price during the Half-year, and the production for the Year is the highest since 1907.

LIONEL C. E. GEE.

Chief Registrar of Mines.

February, 23rd, 1914.

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Mining Operations during the Half-year ended December 31st, 1913.

AREA AT PRESENT HELD UNDER MINING ACTS (DECEMBER 31ST, 1913).

Nature of Holding.	Number.	Area.
Mineral leases	251	12,071 acres
Gold leases	65	1,219 "
Gold dredging leases	1	200 "
Miscellaneous leases	59	15,280 "
Coal and oil leases	1	640 "
Mineral claims	591	22,852 "
Occupation licences	199	99½ "
Search licences	144	343,680 "
Coal and oil claims	26	16,640 "
Gold claims	5	12 "
Total holdings	1,342	412,693½ acres

REGISTERED FROM JUNE 30TH, 1913, TO DECEMBER 31ST, 1913.

Mineral leases	14	526 acres
Gold leases	6	120 "
Gold dredging leases	1	200 "
Miscellaneous leases	3	150 "
Coal and oil leases	1	640 "
Mineral claims	129	5,120 "
Coal and oil claims	27	17,280 "
Gold claims	5	12 "
Occupation licences	24	12 "
Search licences	126	200,320 "
Miners' rights	664	—
Total	1,000	224,380 acres

MEN EMPLOYED.

Estimated number of men employed in mining and mineral works, December 31st, 1913 :—

Copper	4,000
Gold	800
Salt	500
Silver-lead	30
Other minerals	450
Smelting works, Port Pirie	1,456
Raising flux in connection therewith	136
Total	7,372

GENERAL NOTES.

The average price of standard copper for the half-year is £69 0s. 2d., the range of prices being—highest, September 17th, £75 7s. 6d.; lowest, July 16th, £62 10s. For the whole year 1913 the average is £68 5s. 8d.

The average for 1912 is £73 1s. 3d., for 1911 £56 1s. 10d., and for the 10 years ended December 31st, 1913, £66 13s. 10d. per ton.

Returns show the amount of copper produced during 1913 to be 143,222cwts. or 17,322cwts. in advance of the total for 1912. This is the highest production, in fact, since 1907, when copper averaged £82 1s. 11d. per ton; but still it must be confessed that, considering the known copper resources of the State, and the very good average prices ruling, our output of copper is disappointingly small.

According to English and Continental advices the future of the copper market may be regarded as distinctly promising. It is notoriously " tricky " and subject to violent fluctuations, but we must hope that investors will study the averages; and with the two things mentioned in our favor, viz., large copper deposits and good average prices, we can surely look forward to the time when our State will again occupy a prominent position as a copper producer.

The *Wallaroo and Moonta* Mining Company in addition to the usual steady work has carried out a vigorous policy of development and opening up new ore bodies. Good progress is being made with the special prospecting work at Moonta.

As the flotation machinery at Wallaroo has proved so successful in ore-dressing a plant has also been installed at Moonta.

The amount of lode material broken is 79,100 tons, and 72,095 tons of 3·07 per cent. to 3·45 per cent. ore treated.

Fourteen tributers have been at work at the *Hamley*, and have produced about 42 tons of copper.

The *Mount Lyell Consols Wallaroo Copper* Company was reconstructed in July, and the mine unwatered in October. Fifty feet of crosscutting was carried out, and a winze sunk 6ft. The work has now stopped, pending the supply and erection of better pumping equipment.

An effort is being made to obtain capital for working on a large scale the *Queen Bee* and *Lux* Mines near Olary.

The party of miners working at the old *Blinman* Mines have been engaged in sinking on two surface veins, 20ft. each, driving and crosscutting at 40-fathom level, and fixing and securing ladder-ways in the old workings. Ore producing about 3½ tons of copper has been marketed. See Inspector's of Mines report page 59.

At the *Belalie* Mine, near Bundaleer, a little shaft-sinking and exploration work has been done. Inspector's report page. 62.

Tumby Bay Mine.—Returns show sunk new shaft 27ft., hard diorite all the way; total depth 166ft. Sunk Stephen's shaft 18ft. 6in., total depth 124ft. Sunk Prisk's shaft 28ft., total depth 100ft., connected with crosscut from Stephen's shaft. A further Government subsidy has been granted to this company.

West Burra.—The prospecting shaft at this new mine had at the end of December reached a depth of 85ft.

At *Mount Gunson Mine* general surface work and exploration is in progress. The East-West Railway construction will soon reach a point near the mine.

At the *Sweet Nell* (Ironstone Lagoon) and the *Monalena* claims near by general prospecting has been done, and a quantity of low-grade ore raised. Nothing has been marketed so far.

A considerable amount of work has been done at the *Pernatty Lagoon Claim*, about a mile N. of the Mount Gunson Mine, in prospecting, tracing up ore bodies, and leaching low-grade ore. It is stated that these copper ore deposits (*vide* Record of Mines, page 119) will shortly be worked in a large and systematic way.

Union Consolidated Copper Mines, Yudnamutana.—Matters seem to be at a standstill here, and it appears that negotiations are in progress for raising further capital.

The only work done at *Mutooroo* was a little tributing in carbonate ore, and treating the mine water by precipitation.

Small lots of copper ore have been sent away from *Paull's, Dorris Fabian, Diamond Jubilee, Mount Coffin, Nichol's Nob*, and other mines near Leigh Creek, *Warra Warra, Windy Creek, Parabarana, Clara, St. Dora* to the N., and *Copper Queen, Black Eagle*, &c., near Beltana.

Returns from *Tarcoola* are very good, 515 tons of stone being treated at the Government plant for 1,330ozs. 11dwts. 9grs. bullion, worth £4,634 15s. 2d., or £9 per ton. Out of this the *Day Dawn* contributed 201 tons for 770ozs. 13dwts. 19grs., worth £2,677 12s. 10d.; and the *Tarcoola Perseverance* 209 tons for 295ozs. 10dwts. 17grs., worth £1,131 11s. 4d. *Vide* page 15.

At *Glendoth* little has been done, 86 tons treated gave 37ozs. 4dwts. 10grs., worth £135 12s. 4d.

From the *Tarcoola Blocks* leases 83 tons were forwarded to the Tarcoola Government plant and returned bullion worth £725 11s. 10d.

From one of the old *Tarcoola West* blocks at Tarcoola, Mr. N. Simons sent 1 ton 14cwts. of silver-lead ore for treatment at the Cockle Creek Works of the Sulphide Corporation, New South Wales. The returns gave 42·5 per cent. lead, with a trace of gold, and 5ozs. silver per ton. In consequence of the heavy cost of cartage no profit was made on the parcel.

The tributers at the *Kitticoola Mine*, Reedy Creek, treated 229 tons for 74ozs. 4dwts. gold. The Assistant Government Geologist has furnished a detail report on this property. *Vide* page 43.

Homeward Bound and *Spanish American* adjoining, near Mannahill.—A small parcel of ore has been treated from the former and some prospecting work done at the latter, and also at the *Klondyke*.

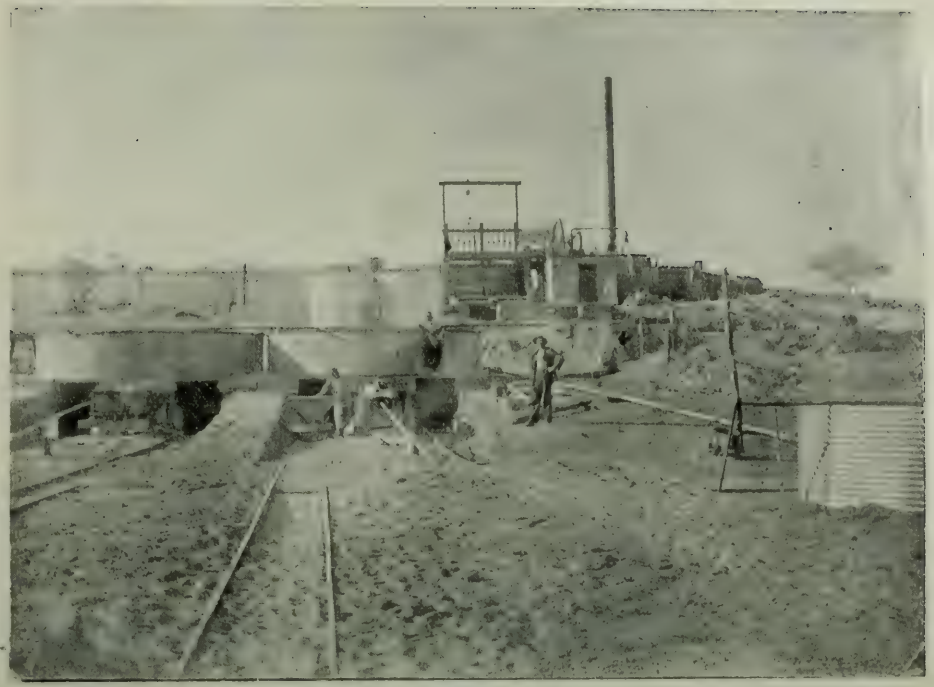
The *Homeward Bound* has changed hands, Major Gottlieb, a veteran of the American Civil War, who has been well known and highly esteemed as a prospector and miner in the N.E. since 1887, has retired from active work, and the mine has been taken over by Mr. John Jones.

At the *Montacute* operations have ceased, except a little alluvial gold mining.

Deloraine Gold Mines.

No shaft-sinking has been done since June 30th, 1913, but the drive S. at the 192ft. level was extended to 148ft., winzes sunk between the 109ft. and 192ft. levels, and a good deal of stoping done. A crosscut put out E. from the 109ft.

To face page 6.



Kirkeek's Treasure.—Battery and Cyanide Plant.

level has passed through two separate mineralised veins of some promise. For the six months ended December 31st, 1913, 996 tons ore were treated, producing 866·7ozs. gold and 2·06 tons copper of a total value of £3,244 17s. 2d. The following statement shows the total production of the mine to October 31st, 1913 :—

	Tons.	Value of Gold Recovered.	Value of Copper Recovered.	Total Gross Value Recovered.
		£ s. d.	£ s. d.	£ s. d.
Ore treated up to April 30th, 1913	2,008	6,014 19 6	200 2 7	6,215 2 1
Ore treated for half-year ended October 31st, 1913.....	959	2,596 6 0	100 7 2	2,696 13 2
	2,967	8,611 5 6	300 9 9	8,911 15 3
Add estimated value of concentrates in transit and on hand	—	—	—	235 0 0
				£9,146 15 3

For the Government Geologist's report on this property, *vide* page 36.

Kirkeek's Treasure.

Mr. J. Heithersay, lessee, has supplied the following return of the gold won from the Kirkeek's Treasure Gold Mine, Nillinghoo, to December 31st, 1913 :—

	Tons cwts. qrs.	Oz. dwts. grs.	£ s. d.
1st Company	1,269 0 0	646 15 1	2,360 14 10
W. H. Carter	485 0 0	780 11 9	2,845 16 5
2nd Company	586 10 0	221 5 15	762 1 10
J. Heithersay	631 0 0	233 3 23	775 0 9
"	56 0 0	28 0 0	78 4 0
"	130 0 0	33 12 0	96 18 6
"	74 0 0	24 6 21	74 15 9
Total quantity ore milled	3,231 10 0	1,967 14 21	6,993 12 1
Tailings treated on the mine, 1,760 tons ..	780 0 0	59 15 8	239 3 0
	980 0 0	130 15 8	523 3 4
	—	2,158 5 13	7,755 18 5

NOTE.—Three thousand two hundred and thirty-one tons 10cwts. of ore yielded 2,158ozs. 5dwts. 13grs. of gold, valued at £7,755 18s. 5d., equal to an average of £2 8s. per ton of ore. One thousand eight hundred feet E. of main workings, as per diagram shown in the Government Half-yearly Mining Review No. 18, a water shaft has been sunk to a depth of 357ft. from the brace, but, so far, only a supply of about 400galls. per diem has been obtained. At 336ft. from the brace a drive going N.E. has been put in for a distance of 59ft. At 42ft. from the shaft dense pyrites were met with, and proved to contain values of 2ozs. 7dwts. of fine gold per ton. This development confirms the correctness of Mr. H. Y. L. Brown's report, dated March 30th, 1897, and also the opinion of Mr. R. L. Jack, Assistant Government Geologist, dated January 13th, 1913. The Chief Inspector of Mines (Mr. W. H. Matthews), the Inspector (Mr. H. Jones), and several other gentlemen of repute have also given very favorable reports on the same property, and the most gratifying feature is that the results being obtained from the battery substantiate the very favorable opinions expressed by them. Further report by Inspector of Mines, *vide* page 54.

Only cyaniding of tailings has been done at *Wadnaminga*, but it was anticipated that crushing on a large parcel from the *Victoria Towers* would soon be started. Inspector's report, page 56.

At the *New Medora* and *Mount Grainger* 120 tons were treated for 28ozs. 19dwts. 1gr., worth £180. The work in progress is stoping by tributers at the 120ft. level. Inspector's report, page 57.

From the *Ajax* (*Babylonian Company*) the last returns show 1,893 tons for 8dwts. per ton. Report by Inspector Jones, page 53.

The Cowell Silver Find.—The two syndicates formed in Melbourne in connection with this locality have now joined forces. The main work done is prospecting, generally by costeens and shallow shafts ; and also sinking and driving at the original find in search of the main ore body. Half a ton of ore was treated for 660ozs. of silver. For detail report by the Inspector of Mines see page 64.

Reports from the *Robertstown Bright Silver-Lead Mine* Show.—Sunk prospecting shaft to 210ft., No. 2 shaft to 35ft., and main shaft started ; crosscut E. and W. in prospecting shaft 60ft. ; drive on ore body in No. 2 shaft and stoped out ore ; erected mine buildings, &c. Seventeen and a half tons of ore sent to Germany for treatment. A report by Inspector Jones will be found on page 58.

It is understood that the *Mount Malvern Mine*, situated between Blackwood and Cherry Gardens, has been purchased by an English company.

Some claims near *Ethiudna Hill* are being worked for cobalt, nickel, and copper, and encouraging assays have been received.

Little work has been done at the coal and oil claims in the hundreds of *Bower*, *Krichauff*, *Sherlock*, and *Seymour*, and *County Cardwell*.

A considerable number of licences to search for oil have been granted, as will be seen in "Mining Operations," page 5. It is understood that matters are almost finalised for the putting down of bores by the companies and syndicates interested in the S. part of Kangaroo Island, the W. side of Eyre Peninsula, and in the S.E.

The Government is offering a bonus of £5,000 for the discovery of oil, under certain conditions, particulars of which will be found on page 14, and have engaged the services of Dr. Arthur Wade, the well-known specialist, to examine and report on the country referred to.

Radium Hill Mine.—A detail report on this, and also on the other workings in the locality, by the Government Geologist will be found at page 26. During 1913 164 tons 14cwts. of concentrates averaging 1·4 per cent. uranium oxide have been forwarded from Olary to the works at Woolwich, near Sydney.

Kirkeek's Treasure.—Shaft sunk for Water.

To face page 10.

It is reported that development at depth is procceding with satisfactory results and that alterations and improvements are to be made both at Woolwich and the concentrating plant on the mine.

S.A. Radium Proprietary, N.E. of and adjoining the Radium Hill Co.'s leases.—Development work in the way of shafts, drives, winzes, and rises has been in progress, and about 400 tons of lode stuff raised. *Vide* report, page 33, by the Government Geologist, on whose recommendation a subsidy has been granted to the company.

Rare Metals Proprietary, near Radium Hill.—Work has proceeded continuously, the deepest shaft is 70ft.; 3½ tons of ore have been sent to Germany, and the N. and S. blocks have been prospected. *Vide* Government Geologist's report, page 34.

Claim 9577 *and others.*—Between S.A. Radium and Rare Metals holdings. Some prospecting has been done in these claims. *Vide* report, page 35.

Since the report on the Radium Hill field (*vide* page 26) was made public, further information has come to hand with regard to certain matters referred to. A paper entitled "Our Radium Resources" was presented by Professor C. L. Parsons at the 16th Annual Convention of the American Mining Congress in Philadelphia during the latter part of October, 1913.

The points of special interest in this recent paper are those concerning the grade of marketable ore and the market price of carnotite ore.

Referring to his former paper entitled "The Uranium and Radium Situation," from which quotations are given by the Government Geologist, C. L. Parsons wrote in this recent publication as follows:—"The publication of this statement has already resulted in an increase of at least 33 per cent. in the price of carnotite ore, and European buyers are awakening to the fact that they must pay to the American miner a price nearer the actual value of his ore. Also a much lower grade is now marketable, for whereas six months ago ore containing 2 per cent. uranium oxide was the lowest grade accepted by European buyers, agents of these buyers are now asking for and actually purchasing ore containing no more than half this content of uranium. Furthermore, the operators are taking more care in separating their low-grade ore from the gangue and in protecting it from wind and weather. Moreover, old dumps are being sold, and ore that a few months ago was thrown aside as valueless will be recovered from them."

The value of ore containing 2 per cent. of uranium oxide in Hamburg is stated to be 95 dollars per ton at the present time.

Radium Extraction Company of South Australia, Limited.

Mount Painter, Flinders Range.—The secretary (Mr. J. K. Samuel) reports that since the last Review was issued this company has sold the two shipments of ore (totalling 25 tons) sent to London, and another 20 tons of ore from 2 per cent. to 5 per cent. U_3O_8 grade is now in transit. In his last half-yearly report, dated October 31st, the manager (Mr. H. G. Stokes, F.G.S.) reported that there were

between six and seven hundred tons of good concentrating ore at grass, and probably over 300 tons of ore in sight above the 50ft. level. A bulk sample of this ore analysed by the School of Mines gave the following result :—

	%
Water at 100° C. (H_2O)	0·37
Water above 100° C. (H_2O)	2·53
Silica (SiO_2)	59·26
Alumina (Al_2O_3)	9·08
Ferric oxide (Fe_2O_3)	16·87
Lime (CaO)	0·40
Magnesia (MgO)	0·11
Soda (Na_2O)	Trace
Potash (K_2O)	2·49
Manganese di-oxide (MnO_2)	6·14
Uranium tri-oxide (UO_3)	0·74
Barium oxide (BaO)	0·64
Copper oxide (CuO)	0·14
Zinc oxide (ZnO)	Trace
Titanium di-oxide (TiO_2)	0·51
Phosphoric anhydride (P_2O_5)	0·44
Sulphuric anhydride (SO_3)	0·18
	99·90

Inquiries are being made in Europe and America as to the best method of concentrating this ore, and leaching experiments are also being carried out at the mine. Development and exploratory work is being pushed forward vigorously.

Mr. Stokes supplies the following notes up to December 31st, 1913 :—

The operations conducted at the mine during the six months ending December 31st, 1913, have been confined to the prospecting of the No. 6 deposit between the 30ft. and 100ft. levels and the shipment of ore from the rich shoot met with in the main shaft above the 50ft. level. Three hundred and six feet of driving, crosscutting, etc., have been carried out. The work done has proved the extension of the rich shoot of ore below the 50ft. level and the occurrence of an E. and W. vein of manganiferous ironstone carrying radio-active minerals ; also the existence of a payable shoot of ore to the S.E. of the shaft. A start has been made to open out E. and W. along the slide at the 100ft. level.

The development of the rich shoot between the 30ft. and 50ft. levels yielded over 40 tons of shipping ore, values ranging from 2 per cent. to over 5 per cent. U_3O_8, besides increasing our tonnage of second grade ore ½ per cent. and over U_3O_8 by 700 tons.

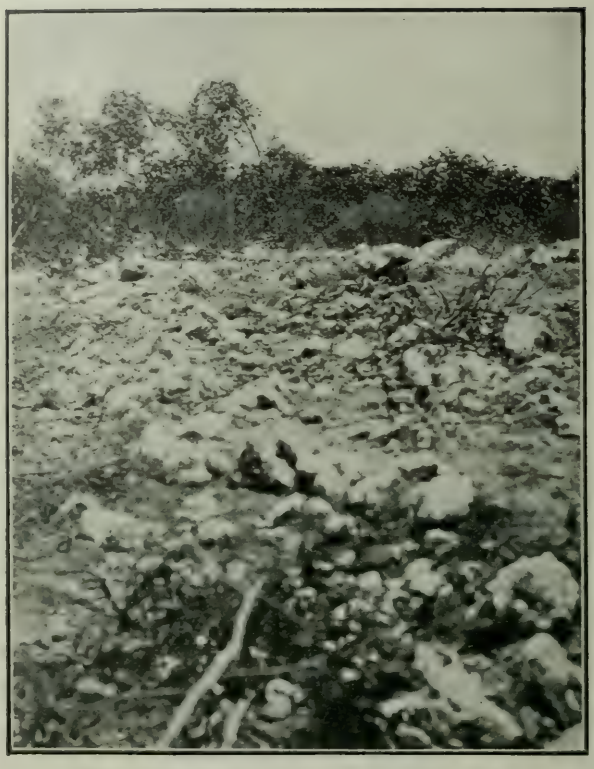
Prospects generally look promising for the development of payable ore below the 50ft. level.

South Australian Radium Deposits Generally.

In answer to inquiries made by the Hon. Minister of Mines from the Imperial Institute, London, the following replies have been received :—

" With regard to the demand for radium bromide, it is stated that several large firms both in the United Kingdom and on the Continent of Europe have been consulted on this point. The opinion generally expressed is that though it is difficult to say how long the present active demand for radium bromide will continue, there are no signs of any falling off in the demand.

" Moreover, it is stated that a high medical authority in London also took the view that the demand for radium bromide is steadily increasing ; but he stated



Magnesite Find.—West of Tumby Bay.

To face page 13.

that the present supply is more or less in the hands of a ring who endeavor to maintain the price at a high level.

"With regard to the market for crude radio-active ores, the Imperial Institute states that the firms consulted were unanimously of opinion that it would be unprofitable to export unconcentrated South Australian ores containing only 2 per cent. of uranium oxide, and that for export to Europe it is essential that radium bromide should be made, or that at least a high-grade radio-active concentrate should be produced.

"It is stated also that the following firms have expressed their readiness to negotiate with the producers with a view to the possible purchase of radium bromide and concentrated radio-active ores from South Australia:—(1) Messrs. Radium Limited, 93, Mortimer Street, London, W. (2) Allgemeene Radium Maatschappij, Amsterdam, Holland. (3) Herr E. de Haën, Chemische Fabrik 'List,' Seelze, near Hanover, Germany."

The ochre mine at *Oodlawirra* has been taken over by a Melbourne company—*The Maltese Cross Dry Color and Paint Co.*

Alunite.—Attention is called to a detail report by the Government Geologist (*vide* page 39).

Magnesite.—A find of magnesite of considerable purity has been made in the hundred of Stokes, near Tumby Bay.

The mineral has many practical uses, and it is hoped that the find will prove of economic value.

About 320 tons of *Barite* have been raised at Woolundunga and near Aldgate.

The salt season, 1912-13, has been an average one, and about 65,000 tons of salt were scraped. The advent of the Australian Salt Company has been the cause of considerable activity at Lake Bumbunga.

DEPARTMENT OF MINES.

"The Native Industries Encouragement Act, 1872."

Notice of the Offer of a Bonus for the Discovery of Oil.

Adelaide, January 19th, 1914.

A bonus of £5,000 is offered to the person or body corporate which first obtains from a bore or well situated in the State of South Australia 100,000galls. of crude petroleum, containing not less than 90 per cent. of products obtainable by distillation.

No application for a bonus will be considered unless the following conditions have been strictly complied with :—

1. The applicant for the bonus must have furnished to the Minister of Mines, during the progress of drilling operations—

(*a*) A monthly record of work done ;

(*b*) A full log of all bores and wells sunk, whether successful or unsuccessful ;

(*c*) Samples of materials passed through by the bores to be taken at every 50ft. sunk, and also at every change of country encountered ;

(*d*) A declaration pursuant to "The Statutory Declarations Act, 1835," of the exact locality of each bore or well. (This should be furnished with the first monthly report on the bore or well).

2. The oil must have been stored at the bore or well from which it has been obtained until the whole 100,000galls. has accumulated.

3. The applicant must furnish with his application—

(*a*) The certificate of a licensed surveyor nominated by the Minister of Mines as to the quantity of oil so stored ;

(*b*) The certificate of the Government Analyst of the result of his analysis of samples of the oil taken by a person nominated by the Minister of Mines ;

(*c*) A declaration pursuant to "The Statutory Declarations Act, 1835," that the whole of the oil for which the bonus is claimed was obtained from the bore or well where it is stored.

4. Within 24 hours of the first discovery of oil in the well or bore, notice of such discovery must be sent to the Minister of Mines.

5. Any person who desires at any time to inspect or test the well or bore on behalf of the Minister of Mines must be granted every facility for this purpose.

6. The applicant must have done nothing contrary to the provisions of "The Mining Act, 1893," or "The Mining Act Amendment Act, 1900," or of any lease or licence granted to the applicant under either of these Acts.

R. BUTLER, Minister of Mines.

Magnesite Find.—West of Tumby Bay.

To face page 14.

CRUSHING AND CYANIDING PLANTS.

RETURNS FROM GOVERNMENT CRUSHING AND CYANIDING PLANTS FOR THE HALF-YEAR ENDED DECEMBER 31ST, 1913.

Name of Mine.	Locality.	Weight of Ore.	Gold Bullion Recovered.	Total Value of Bullion.	Yield per Ton, in Shillings.
		Tons cwts. qrs.	Ozs. dwts. grs.	£ s. d.	s.
TARCOOLA BATTERY AND CYANIDE WORKS.					
Day Dawn	Tarcoola	50 0 0	33 7 19	101 0 0	40½
Tarcoola Perseverance	"	50 0 0	44 14 23	173 3 4	69¼
Tarcoola Perseverance	"	53 0 0	103 1 13	381 15 8	144
Tarcoola Blocks	"	12 0 0	21 2 8	74 11 4	35¼
Day Dawn	"	51 0 0	23 14 6	65 16 1	25¾
Tarcoola Blocks	"	15 10 0	12 16 3	39 13 11	51¼
Tarcoola Perseverance	"	55 0 0	80 4 16	307 19 11	112
Tarcoola Enterprise..	"	12 0 0	29 18 1	110 4 2	183¾
Day Dawn	"	50 0 0	347 5 0	1,289 18 0	316
Tarcoola Perseverance	"	51 0 0	67 9 13	258 12 5	101½
Tarcoola Blocks	"	25 0 0	105 12 14	394 13 4	315¾
Tarcoola Blocks	"	14 10 0	80 16 16	169 17 7	234¼
Day Dawn	"	50 0 0	366 6 18	1,220 18 9	288¼
Tarcoola Blocks	"	26 0 0	14 1 3	46 10 8	35¾
Total.....		515 0 0	1,330 11 9	4,634 15 2	180
Grand total since starting of battery ..		4,629 5 0	7,076 6 8	24,887 15 0	103¼
GLENLOTH BATTERY AND CYANIDE WORKS.					
Fabians No. 3	Glenloth	36 0 0	15 14 17	62 18 10	35
Glen Markie	"	25 0 0	12 11 15	42 1 3	33¾
Glen Markie	"	25 0 0	8 18 2	30 12 3	24½
Total		86 0 0	37 4 10	135 12 4	31½
Grand total since starting of battery ..		2,319 10 0	2,087 5 18	6,993 9 11	60¼
PETERSBURG BATTERY AND CYANIDE WORKS.					
Queen Mary	Parnaroo	5 15 0	1 7 7	4 16 2	16¾
Only a Dream	"	5 0 0	0 18 0	3 3 5	12¾
Homeward Bound (Wanda)	Mannahill.....	4 10 0	3 13 18	14 13 9	75¼
Golden Junction	Oodla Wirra.....	5 1 0	12 10 22	48 16 1	193¼
Watkin's	"	5 0 0	1 0 22	3 17 5	15½
Total.....		25 6 0	19 10 21	75 6 10	59½
Grand total since starting of battery ..		4,656 0 0	4,245 9 4	15,824 1 8	68
MOUNT TORRENS CYANIDE WORKS.					
Mount Torrens.....	Mount Torrens....	100 0 0	12 1 8	36 5 0	7¼
Mount Torrens.....	"	8 0 0	4 1 8	14 7 9	36
Total.....		108 0 0	16 2 16	50 12 9	9¼
Grand total since starting of battery ..		10,352 11 3	5,907 3 23	22,366 5 2	43

RETURNS FROM CRUSHING AND CYANIDING PLANTS (OTHER THAN GOVERNMENT) FOR THE HALF-YEAR ENDED DECEMBER 31ST, 1913

Name.	Ore Treated.	Gold Bullion Recovered.	Value.	Yield per Ton, in Shillings.
	Tons cwts. qrs.	Ozs. dwts. grs.	£ s. d.	s.
KITTICOOLA, REEDY CREEK.				
Battery treatment	229 0 0	74 4 0	236 19 10	—
Total	229 0 0	74 4 0	236 19 10	20¾
KIRKEEK'S TREASURE, NILLINGHOO.				
Battery treatment	260 0 0	85 3 0	449 18 3	—
Total	260 0 0	85 3 0	449 18 3	34½
NEW MEDORA AND GRAINGER COMPANY, MOUNT GRAINGER.				
Battery treatment	120 0 0	28 19 1	180 0 0	—
Total	120 0 0	28 19 1	180 0 0	30
AJAX (BABYLONIAN G.M.C.), NEAR WAUKARINGA.				
Battery treatment	1,893 0 0	757 0 0	2,272 7 2	—
Total	1,893 0 0	757 0 0	2,272 7 2	24
WADNAMINGA (Mr. O. W. ALLANSON).				
Virginia (old tailings cyanided)	1,112 0 0	193 10 0	409 15 9	—
Total	1,112 0 0	193 10 0	409 15 9	7¼
DELORAINE GOLD MINES, NO-LIABILITY.				
Battery treatment	996 0 0	866 14 6	3,101 3 2	—
Total*	996 0 0	866 14 6	3,101 3 2	62¼

* Also 2·06 tons copper worth £143 14s. 0d.

TOTAL BATTERY AND CYANIDE RETURNS FROM ALL PLANTS FOR SIX MONTHS ENDED DECEMBER 31ST, 1913.

Name.	Ore Treated.			Gold Bullion Recovered.			Value.			Yield per Ton, in Shillings
	Tons.	cwts.	qrs.	Ozs.	dwts	grs.	£	s.	d.	s.
Tarcoola	515	0	0	1,330	11	9	4,634	15	2	180
Glenloth	86	0	0	37	4	10	135	12	4	31½
Petersburg	25	6	0	19	10	21	75	6	10	59½
Mount Torrens	108	0	0	16	2	16	50	12	9	9¼
Kitticoola	229	0	0	74	4	0	236	19	10	20¾
Kirkeek's Treasure	260	0	0	85	3	0	449	18	3	34⅕
Medora and Grainger	120	0	0	28	19	1	180	0	0	30
Ajax (Babylonian G.M.C.)	1,893	0	0	757	0	0	2,272	7	2	24
Wadnaminga	1,112	0	0	193	10	0	409	15	9	7¼
Deloraine	996	0	0	866	14	0	3,101	3	2	62¼
Total	5,344	6	0	3,408	19	9	11,546	11	3	43¼

COPPER.

AVERAGE MONTHLY PRICE OF COPPER, JULY TO DECEMBER, 1913.

	Standard.				Best Selected.		
	£	s.	d.		£	s.	d.
July	64	5	10	..	69	14	5
August	69	6	0	..	74	4	0
September	73	5	3	..	78	16	1
October	73	9	5	..	78	18	4
November	62	8	9	..	73	12	6
December	65	5	7	..	70	0	0
Average for the six months	69	0	1⅔	..	74	4	2⅔

RANGE OF PRICES—

July 16th	63	10	0
September 17th	75	7	6

AVERAGE PRICE OF STANDARD COPPER FOR THE LAST TEN YEARS.

	£	s.	d.		£	s.	d.
1904	59	0	7	1909	58	17	2
1905	64	16	10	1910	57	3	3
1906	87	8	10	1911	56	1	10
1907	82	1	11	1912	73	1	3
1908	60	0	10	1913	68	5	8

Average for the 10 years, £66 13s. 10d.

REPORTS ON BORING OPERATIONS.

BORING OPERATIONS AT THE YELTA MINE, MOONTA.

Report by Mr. A. W. Matthews, Foreman.

Nos. 5, 6, and 7 bore holes were completed, making a total footage of 1,273ft.

No. 5. Bore.

Started near No. 1 prospecting shaft. Angle, 15ft. in 100ft., and marked out to cut the lode at 300ft. Boring started with 3½in. bit.

Surface to 6ft.	Surface loam and limestone.
to 29ft.	Sandstone.
to 31ft.	Micaceous schist.
to 86ft.	Red and blue country rock.
to 93ft.	Formation carrying a little pyrites and yellow sulphide.
to 139ft.	Very broken country.
to 148ft.	Country showing specks of sulphide and fair amount of mundic.
to 193ft.	Broken country.
to 197ft.	Country showing quartz seams and a little sulphide.
to 217ft.	Broken country.
to 227ft.	Country showing iron pyrites.
to 237ft.	Low grade lode showing yellow sulphide and mundic
to 269ft.	Country.
to 270ft.	Soft flucan.
to 304ft.	Hard red country.
to 340ft.	Blue country.
to 445ft.	Hard red country.

No. 6 Bore.

Opposite Waring's shaft. Angle, 25ft. in 100ft., and marked out to cut lode at 350ft. on underlie.

Surface to 8ft.	Surface loam and limestone.
to 111ft.	Hard red country.
to 117ft.	Schist showing little mineral.

to 231ft. Red country.
to 231ft. 8in. Quartz.
to 260ft. 2in. Country.
to 260ft. 10in. Iron pyrites carrying a little yellow sulphide.
to 271ft. Country.
to 273ft. Country showing iron pyrites and little sulphide.
to 286ft. 5in. Country.
to 288ft. Low-grade ore.
to 301ft. Country.
to 302ft. 6in. Formation showing yellow sulphide.
to 374ft. Broken red country rock.

No. 7. Bore.

Angle, 20ft. in 100ft., and marked out to cut the lode at 400ft on the underlie, and 50ft. S. of Scott's shaft.

Surface to 4ft. Surface loam and limestone.
to 67ft. Very hard and broken red country.
to 198ft. Blue country.
to 198ft. 6in. Quartz leader.
to 218ft. Broken country.
to 225ft. Micaceous schist, showing a little sulphide.
to 278ft. Broken country.
to 278ft. 8in. Mica.
to 279ft. Quartz.
to 282ft. Low-grade ore, mostly hematite with few specks yellow ore.
to 341ft. Hard red country.
to 381ft. Blue country carrying little sulphide and iron pyrites.
to 383ft. Quartz showing a little sulphide.
to 404ft. Red and blue country showing little sulphide and iron pyrites.

to 404ft. 1in.	Seam of yellow ore.
to 406ft.	Mineralised country.
to 407ft. 5in.	Lode showing fair amount of yellow sulphide.
to 414ft. 3in.	Red country.
to 414ft. 9in.	Lode showing a fair amount of yellow ore.
to 415ft. 10in.	Mineralised country.
to 416ft. 10in.	Lode showing little yellow ore.
to 433ft. 6in.	Country showing mineral.
to 439ft. 6in.	Iron and mica (very soft).
to 441ft. 6in.	Lode material.
to 454ft.	Country.

BORING OPERATIONS AT THE AJAX MINE, NEAR WAUKARINGA.

Report by Mr. C. F. Duffield, Foreman.

On the completion of No. 2 Bore the plant was removed to a site 4 chains S.W. from the Ajax Lease and 520ft. back from the lode. Angle of bore, 30ft. in 100ft. to cut the lode at 400ft. Boring operations were started on August 13th, the country passed through being as follows :—

Surface to 2ft.	Limestone.
to 13ft.	Ferruginous sandstone mixed with slate.
to 46ft.	Blue slate.
to 95ft.	Blue slate with occasional quartz and ironstone seams.
to 95ft. 2in.	Small seam of oxide of iron and quartz.
to 139ft.	Yellow sandstone and slate.
to 189ft.	Blue slate.
to 248ft.	Calcareous slate country.
to 248ft. 1in.	Quartz and calcite seam showing pyrites.
to	Calcareous slate.

300ft. 6in.
to Quartz seam highly charged with pyrites.
300ft. 7in.
to Blue calcareous slate, then small seam of quartz.
328ft.
to Blue slate with occasional quartz veins and ironstone stains.
358ft.
to Hard blue slate, then 1½in. seam of quartz and pyrites.
391ft.
to Blue slate country with occasional calcite seams.
439ft.
to Hard blue quartzite.
447ft.
to Slate country.
470ft.
to Hard blue country rock.
488ft.

At this depth it was decided to discontinue boring, and remove the plant to a site on the Ajax Lease, 208ft. N.W. from the outcrop to cut the lode at 160ft. Angle of bore, 30ft. in 100ft., dipping S.E. The country passed through being as follows :—

Surface
to Limestone.
1ft. 6in.
to Blue slate and sandstone (¼) seam of quartz and ironstone.
54ft.
to Blue slate with calcite seam and ironstone stains.
148ft.
to Blue slate.
156ft. 3in.
to Lode formation.
157ft. 7in.
to Passed through lode consisting of oxide of iron, quartz, and calcite.
158ft. 4in.
to Soft clay slate footwall.
159ft. 9in.
to Blue slate country.
172ft.

Lode assayed nearly 1oz. to the ton. The plant was then removed to a site at the N.E. end of the lease and 520ft. back from the line of lode to cut same at 400ft , the country passed through being as follows :—

Surface
to Sandstone mixed with slate.
50ft.
to There has been no decided change in the bore, the country being chiefly
332ft. blue slate with occasional quartz and calcite seams.

Boring in progress.

SUBSIDIES.

The Legislature provided in the Mining Act, 1893, and in previous measures for the encouragement of Mining.

The following schedule shows what subsidies have been paid from the inception of the system to December 31st, 1913, and the sums repaid. In the ordinary way these repayments are made from profits—50 per cent. of such profits being devoted to repayments In two instances only have the profits won enabled full repayments to be accomplished—the Crystal Mine, at Echunga, which repaid £76 7s. 6d. from that source, and the once-famous New Alma and Victoria Mine, Waukaringa, which repaid in full the first subsidy, £3,000. The remainder of the recoveries was derived from sales of mining plant held as security. The total subsidies advanced is £58,209 5s. 0d. of which £7,582 14s. 1d. has been recovered, leaving a debit balance of £50,626 10s. 11d. Portion of this outstanding debt is represented by machinery that has fallen into the hands of the Government; add to this the value of the metals won, and the State in general will probably have benefited beyond the money value of the debit balance.

STATEMENT OF SUBSIDIES PAID FROM COMMENCEMENT TO DECEMBER 31ST, 1913.

Name of Company or Person to whom Subsidy Granted.	Locality.	Amount Advanced.			Amount Repaid.		
		£	s.	d.	£	s.	d.
Adelaide Crushing, Grinding, and Amalgamating Mill Co.	—	100	0	0	—		
Algebuckina Gold Mining Syndicate	Algebuckina	52	10	11	52	10	11
Alma Extended Gold Mining Co.	Waukaringa	3,000	0	0	172	5	0
Backhouse, T. S.	Worturpa	100	0	0	—		
Barossa Enterprise Gold Mining Coy.	Barossa, Hundred of	232	2	6	—		
Belalie Copper Mining Syndicate	Bundaleer	392	12	3	—		
Beltana Rapid Ore Treatment Syndicate	Near Beltana	296	8	4	—		
Bevilaqua & Angel	Palmer (near)	57	18	0	—		
Bird-in-Hand Gold Mining Co., Ltd.	Woodside	3,000	0	0	—		
Blackfellow's Creek Gold Mining Co., Ltd.	Kuitpo, Hundred of	660	6	7	35	0	0
Callington Copper Mining Co.	Callington	148	8	7	—		
Cockburn Copper Mining Co., N.L.	Mutooroo	273	18	5	173	13	8
Commonwealth Silver-lead Co., Ltd.	Strathalbyn, Hund. of	750	0	0	52	17	9
Copper Hill Mining Co., N.L.	Kadina	391	15	6	115	0	0
Cornwall Copper Mining Syndicate, N.L.	Kadina, Hundred of	500	0	0	—		
Countess of Jersey Gold Mining Co., N.L.	Wadnaminga	321	0	0	—		
Currency Creek Copper Mining Co.	Currency Creek	28	6	5	20	0	3
Crystal Gold Mining Co.	Echunga	563	17	6	176	7	6
Ding Dong Copper Mining Syndicate	Kanmantoo, Hund. of	124	0	4	—		
Duke of Cornwall Gold Mining Syndicate	Mount Pleasant	458	17	4	43	10	0
Eagle Silver Mining Co., Ltd.	Glen Osmond	500	0	0	—		
Ediacara Consols Silver Mining Co., N.L.	Ediacara	651	12	1	465	17	0
Enterprise Copper Mining Co., N.L.	Barossa, Hundred of	150	0	0	9	16	0
Enterprise Excelsior (Barossa Amalgamated)	"	2,000	0	0	—		
Eureka Gold Mining Co., Ltd.	Woodside	1,500	0	0	—		
Fifth Creek Central Silver and Copper Mining Co., N.L.	Fifth Creek	253	2	4	—		
Fortress Hill Mining Syndicate	Fortress Hill	60	0	0	—		
Glenloth Mining, Battery, & Options Co., N.L.	Glenloth	515	4	7	515	4	7
Glenloth Wells Pioneer Blocks Co., Ltd.	"	100	0	0	22	18	5
Gumeracha Gold Mining Syndicate	Gumeracha	75	0	0	—		
Golden Point Claims	Wonna	50	0	0	—		
Great Ironclad Gold Mining Co.	Teetulpa	218	6	9	—		
Hakendorf, C. H., and Williams, J. (Glenmarkie Mine)	Glenloth	221	17	6	—		
Hamley Copper Mining Co.	Wallaroo	2,000	0	0	—		
Homeward Bound and Klondyke Gold Mines, N.L.	Mannahill	192	17	1	—		
Heithersay, J. (Kirkeeks Treasure Mine)	Waukaringa	300	0	0	—		

STATEMENT OF SUBSIDIES PAID—*continued.*

Name of Company or Person to whom Subsidy Granted.	Locality.	Amount Advanced. £	s.	d.	Amount Repaid. £	s.	d.
Hunter Bros. (Lady Millicent Mine and Nuccaleena Mines)	Mochatoona	228	17	0	—		
Ireby Gold Mining Syndicate	Mount Grainger	35	4	3	—		
Kanmantoo Copper Mines Syndicate, N.L.	Kanmantoo	150	2	1	—		
Kingsborough, W. A. (Benowrie Mine)	Near Cutana	30	15	0	—		
Kirkeek's Treasure Gold Mining Co.	Waukaringa	691	8	1	—		
King's Bluff G.M. Co., N.L.	Olary	622	0	8	—		
Kohinoor Gold Mining Co., N.L.	Kangaroo Island	100	0	0	—		
Kohinoor Mine (H. G. Taylor)	"	200	0	0	—		
Lady Alice Gold Mining Co.	Barossa, Hundred of	1,797	2	3	—		
Lady Franklin Syndicate	Port Lincoln	200	0	0	40	0	0
Leigh's Creek South Coal Mining Co., N.L.	Leigh's Creek	95	16	4	95	16	4
McMurtie's Claims	Kuitpo, Hundred of	199	19	11	—		
Mingary Gold Mining Co.	New Luxemburg	400	0	0	—		
Montacute Gold and Copper Mining Co., N.L.	Sixth Creek	400	0	0	—		
Mount Victoria Mine	Bimbowrie	50	0	0	—		
Mount Malvern Silver Mining Co.	Blackwood	491	3	6	—		
Mount Malvern Silver-lead Mining Co., N.L.	Clarendon	1,347	15	3	—		
Mount Pangæus Gold Mining Co.	Hahndorf (near)	56	1	4	—		
Mount Monster Gold Mining Syndicate	Kuitpo, Hundred of	350	0	0	1	0	0
Mt. Grainger Ironclad Gold Mining Syn., Ltd.	Mount Grainger	21	18	10	—		
Mount Torrens Gold Mining Co.	Mount Torrens	1,000	0	0	—		
Mount Remarkable Mining Co., Ltd.	Wongyarra, Hund. of	122	8	1	15	0	0
Musgrave Ranges Prospecting Association	Musgrave Ranges	47	2	9	—		
Mount Painter Corundum and Gem Syndicate	Mount Painter	47	3	1	—		
Morning Star Gold Mining Co.	Teetulpa	68	4	6	—		
Mutooroo Copper and Silver Mining Co., Ltd.	Mutooroo	500	0	0	500	0	0
Nackara Proprietary Copper Mining Co., N.L.	Nackara	100	0	0	—		
Nackara Proprietary Gold Mining Syndicate.	Nackara	100	0	0	—		
New Banksia Gold Mining Syndicate	Nairne	250	0	0	—		
New Alma and Victoria Gold Mining Co., Ld.	Waukaringa	3,000	0	0	3,000	0	0
New Ajax Consolidated Gold Mining Co., N.L.	"	750	0	0	—		
New Era Gold Mining Co., Ltd.	Woodside	1,000	0	0	—		
New Glenloth Battery and Mining Co., N.L.	Glenloth	750	0	0	—		
New Medora and Grainger Gold Mines Syn., N.L.	Mount Grainger	1,421	9	9	—		
New Mingary Gold Mining Co.	New Luxemburg	250	0	0	—		
New Mount Grainger Gold Mines, N.L.	Mount Grainger	393	7	1	220	0	0
Northern Mining and Smelting Co., N.L.	Mount Fitton	350	0	0	—		
North Nairne Gold Mining Co.	Nairne	500	0	0	—		
North-West and West Australian Pros. Co.	North-west of S.A.	104	9	7	—		
North-West Prospecting Association, N.L.	Tarcoola	150	0	0	—		
Nil Desperandum Teetulpa Devt. Co., N.L.	Teetulpa	64	14	4	20	5	6
Nilpena Copper Mining Co., Ltd.	Blinman	290	5	3	—		
Onkaparinga Dredging and Mining Co. and Echunga Propy. Hydraulic Gold Sluicing Co.	Biggs' Flat	1,050	0	0	700	0	0
Paull's Consolidated Copper Propy., N.L.	Burr Well	525	0	0	13	9	0
Parara Mining Co., N.L.	Maitland	571	3	6	—		
Paringa Mining Syndicate	Callington	399	16	8	244	0	0
Paringa and West Kanmantoo Consolidated Copper Mine, N.L.	"	1,144	3	4	10	5	0
Pioneer Gold and Copper Mining Syndicate	"	95	15	6	—		
Polmear, W. J. L.	Kadina	800	0	0	—		
Queen Bee Mining Co., N.L.	New Luxemberg	250	0	0	250	0	0
Quorn Manganese and Silver Mining Co.	Quorn	10	9	10	—		
Rapid Bay Silver Mining Co., N.L.	Yankalilla, Hund. of	136	2	4	—		
Robertstown Bright Silver Lead Mines	Hd. Bright	122	16	5	—		
Royal Charlie Gold Mining Co.	Mannahill	153	18	5	—		
Rees, R., Ajax Mine	Waukaringa	604	14	5	—		
Stainbank, A. T.	Fifth Creek	70	14	11	—		
Sliding Rock Copper Proprietary, N.L.	Sliding Rock	2,000	0	0	25	7	0
Tarcoola Blocks Gold Mining Co., Ltd.	Tarcoola	3,995	5	2	150	19	11
Tarcoola Enterprise Gold Mining Co., N.L.	"	100	0	0	19	10	4

STATEMENT OF SUBSIDIES PAID—*continued.*

Name of Company or Person to whom Subsidy Granted	Locality.	Amount Advanced.			Amount Repaid.		
		£	s.	d.	£	s.	d.
Tarcoola Proprietary Gold Mines, N.L.	Tarcoola	150	4	4	9	15	0
Teatree Gully Gold Mining and Pros. Assn.	Teatree Gully.....	234	5	7	—		
Teetulpa Mining and Crushing Co.	Teetulpa	349	11	4	—		
Teetulpa Prospecting Syndicate	"	49	15	6	—		
Tumby Bay Copper Mining Co., N.L.	Hutchison, Hund. of..	400	0	0	—		
Victoria Hill Amalgamated Gold Mining Syn.	Barossa, Hundred of ..	38	12	6	—		
Victoria Tower Mining Co., N.L.....	Mannahill	345	18	9	90	0	0
Warrakimbo Propy. Copper Mining Synd...	Barndioota, Hundred of	220	16	2	—		
Warra Warra Propy. Copper Mines, N.L. ..	Farina	322	4	11	322	4	11
Watt's Gully Gold Mining Co.	Gumeracha	50	0	0	—		
Watt's Gully Reef Claims	Gumeracha	50	0	0	—		
Wolters, F. C., & Co	Echunga	25	0	0	—		
Wallaroo Central Mining Co., N.L.....	Kadina	500	0	0	—		
Westward Ho Mine (Dr. H. Dixon)	Mannahill	1,000	0	0	—		
Wohler, H., & Co.	Myponga.....	20	0	0	—		
Wheal Turner Copper Mining Co., Ltd.	Prospecting on proposed line to Queensl'd Border	1,000	0	0	—		
Winnininnie Gold & Silver Propy. Co., N.L.	Winnininnie	86	3	6	—		
Woodside Boring and Mining Syndicate	Woodside	422	17	11	—		
Worturpa Exploration and Mining Co., Ltd.	Worturpa	800	0	0	—		
Yelta New Copper Mining Co., N.L.	Wallaroo	1,000	0	0	—		
Young Bullfinch Gold Mining Co., N.L.....	Talunga, Hundred of	146	3	4	—		
Totals	—	58,209	5	0	7,582	14	1

ACCIDENTS IN MINES AND QUARRIES.

A gratifying feature of our mining operations in mines and quarries is the infrequency of serious accidents. Act No. 858 of 1904, bringing quarries in the same category as mines as regards the control of the Chief Inspector of Mines has been effective in safeguarding the interests of quarry-men. The following table gives the number of accidents in mines and quarries since passing of the Act:—

ACCIDENTS IN MINES AND QUARRIES.

Accidents in Mines.				Accidents in Quarries.			
Year.	Total Number of Accidents Reported.	Number of Persons Injured.	Number of Persons Killed.	Year.	Total Number of Accidents Reported.	Number of Persons Injured.	Number of Persons Killed.
1904	5	1	4	1904	1	1	1
1905	3	1	3	1905	—	—	—
1906	5	—	3	1906	1	1	—
1907	8	4	6	1907	3	1	2
1908	5	4	1	1908	—	—	—
1909	6	5	1	1909	1	1	—
1910	5	3	3	1910	2	1	1
1911	2	—	2	1911	—	—	—
1912	3	2	1	1912	2	—	2
1913	10	8	2	1913	—	—	—

ASSAYS AT SCHOOL OF MINES.

NUMBER OF ASSAYS MADE FOR PUBLIC PURPOSES AT THE SCHOOL OF MINES ASSAY DEPARTMENT DURING THE SIX MONTHS ENDED DECEMBER 31ST, 1913.

	1913.					
	July.	August.	Sept.	Oct.	Nov.	Dec.
Department of Mines	67	18	78	76	137	64
Public assays.....	103	95	137	74	66	78
Totals.....	170	113	215	150	203	142

DECENNIAL RETURN SHOWING OUTPUT AND VALUE OF VARIOUS METALS AND MINERALS PRODUCED IN SOUTH AUSTRALIA SO FAR AS CAN BE ASCERTAINED.

Year.	Gold.		Silver.		Silver Lead Ore.		Copper.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Ounces.	£	Ounces.	£	Tons.	£	Cwts.	£
1904	17,897	76,025	—	—	—	—	125,560	382,356
1905	10,983	45,853	—	—	—	—	130,959	426,511
1906	8,037	27,000	801	104	—	—	164,160	718,609
1907	5,609	20,540	5,845	780	1,000	11,000	158,620	690,000
1908	2,908	12,300	—	—	900	9,000	112,554	338,000
1909	7,111	30,206	1,660	167	70	416	113,940	334,584
1910	6,603	28,000	6,250	625	25	22	102,040	306,120
1911	3,537	15,000	1,400	140	—	—	118,440	332,500
1912	6,592	28,000	2,700	326	—	—	125,900	461,500
1913	6,556	27,800	2,650	300	153	1,100	143,222	488,986
Totals....	—	310,724	—	2,442	—	21,538	—	4,479,166

Year.	Copper Ore and Regulus.		Lead.		Ironstone Flux.		Limestone Flux.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value
	Tons.	£	Cwts.	£	Tons.	£	Tons.	£
1904	3,051	24,597	—	—	46,687	27,091	43,440	6,516
1905	2,563	28,434	1,040	369	84,483	48,577	44,498	4,791
1906	—	—	1,000	550	75,226	33,852	31,940	4,791
1907	—	—	—	—	84,600	38,100	31,100	5,800
1908	—	—	—	—	88,000	39,600	29,500	6,000
1909	1,230	4,003	140	90	16,120	8,296	13,765	2,464
1910	—	*9,350	400	260	46,200	21,945	18,600	3,720
1911	—	*11,103	—	—	42,300	26,400	28,700	7,175
1912	—	*10,192	—	—	42,200	26,375	50,600	12,500
1913	—	*8,308	—	—	60,658	37,911	44,300	11,075
Totals	—	95,987	—	1,269	—	308,187	—	64,832

Year.	Phosphate Rock.		Crude Salt.		Other Metals and Minerals.	Total Value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Tons.	£	Tons.	£	£	£
1904.....	3,000	3,000	40,000	12,000	198	531,783
1905.....	5,000	5,000	32,500	13,000	1,261	573,796
1906.....	5,850	5,850	55,000	27,500	2,209	820,465
1907.....	8,000	8,000	75,000	37,500	2,500	814,220
1908.....	11,000	11,000	75,000	37,500	4,500	457,900
1909.....	3,772	3,697	51,407	25,594	3,873	413,390
1910.....	5,200	5,200	54,000	27,000	†13,600	415,842
1911.....	5,800	5,800	65,000	40,600	†11,319	450,054
1912.....	6,100	6,100	64,300	40,187	†10,490	595,670
1913.....	5,950	6,545	65,000	48,750	†11,851	642,626
Totals	—	60,192	—	309,631	61,801	5,715,746

* Bluestone, £5,980; Sulphuric Acid, £3,370.
" £4,163 " £6,940.
" £2,550 " £7,642.
" £325 " £7,983.

† Including Gypsum, £9,000; Pyrites, £3,270.
" £7,275; " £2,580.
" £9,000.
" £5,362.

REPORTS FORMING ADDENDA TO THE RECORD OF MINES.

REPORTS

BY

The Government Geologist (L. Keith Ward, B.A., B.E.).

THE RADIUM HILL MINING FIELD.

LOCALITY—NORTH-EAST.

The Radium Hill Mining Field was visited by the writer, under instructions from the Honorable the Minister of Mines, during the period August 19th to September 2nd, 1913.

The area with which this report is concerned comprises some four and a half square miles. The centre of the district is situated at a distance of 12 miles to the south south-east of Cutana Siding, on the Broken Hill railway line. In this area there are at present 37 mineral leases and 20 mineral claims held under the Mining Act, and each of the leases or claims comprises an area of 40 acres. The district is within comparatively easy reach of the Broken Hill railway, and supplies are brought to it from Cutana or Olary.

Only a few miles to the westward of the Radium Hill district are situated two copper mines, known as the Mildaltie and the Dalkey. Eight miles to the north-west lie the New Luxemburg Gold Mine and the Queen Bee Copper Mine. At a similar distance to the northward are the iron ore quarries which formerly supplied Broken Hill with ironstone flux. The Mutooroo Mine is but 18 miles away in an east north-easterly direction. Thus it appears that the Radium Hill district is centrally situated in a highly mineralised region.

General Geology.—The uranium-radium mines of the Radium Hill district are situated within a geological terrain which exhibits marked differences in character from the Cambrian area lying to the westward. Whereas the Cambrian terrain, as represented in the Olary district, comprises a great series of almost unaltered sediments traversed by white quartz veins, but almost wholly free from igneous intrusions, the area with which this report deals is characterised by a marked predominance of igneous rock types. An almost exactly parallel occurrence has been noted for the area in which the uranium-radium lodes of Mount Painter are found. The close resemblance between the general geological features of the two regions probably stands in intimate genetic relationship to the occurrence of uranium in each, though it is not possible to indicate a direct relationship between the lodes and any specific group of rocks.

At a first glance of the rocks of the Radium Hill district give the impression of being altogether of igneous origin, but affected by metamorphism to such a degree that gneisses and foliated schists have been produced. A closer examination, however, shows that here and there, as for instance, to the westward of Bonython Hill, beds of almost unaltered sediments occur intercalated in the rocks of schistose or gneissose appearance. Moreover, the occurrence of garnet, staurolite and cyanite in certain of the schists affords almost incontrovertible evidence of a sedimentary origin for the materials whence the schists were derived. The semblance of an igneous derivation is due to the innumerable intrusions of granitic or pegmatitic material

which have in places wholly masked the sedimentary characters. As is usually the case where pegmatitic intrusions are abundant in schistose rocks, there is to be found every gradation between pegmatized schist (i.e., a banded rock of gneissic appearance) and the quartzo-felspathic pegmatite which bears no trace of the foliation of the schists into which it has intruded.

There is to be recognised, where the alluvial cover is not present, a general coincidence between the strike of the foliation planes and the majority of the pegmatite intrusions, but exceptions do occur.

The later igneous invasions are of a basic type, and possess no uniformity of trend nor any parallelism to the planes of foliation of the schists. One intrusion of this amphibolite situated near the northern corner of M.L. 341 has a circular outcrop which is 30ft. in diameter. The orientation of many of the amphibolite dykes is obscured by alluvium.

From the few exposures now available for examination it would appear that the period of the genesis of the lode formations suceeded that of the amphibolitic intrusions.

No other constructive geological agencies have left any trace of their operation between the period of ore deposition and Recent times, when the alluvium of the broad and usually ill-defined valleys accumulated.

Denudation has long been in progress throughout the whole region, and has advanced to such a stage of maturity that few prominences remain ; these, such as Bonython Hill, owing their slight relief to the greater resistance of the rocks of which they are composed.

Physiographically the district merges into the great peneplain which extends southwards to the Murray River. It is located immediately above the upper edge of this enormous peneplaned area, which is occupied at its lower levels by Tertiary and Recent sediments, but which embraces at its border a wide belt of Cambrian and pre-Cambrian rocks covered with a shallow mantle of rock waste.

Economic Geology.—The points of economic interest in connection with the area are the mineral composition of the ore bodies and the mode of occurrence of these ore bodies.

The mineral constitution of the lodes which carry the uranium and radium values is by no means simple. In the first place the primary uraniferous minerals present in the lodes are not discernible in the bulk of the lode matter. Traces of pitch blende have been detected by Dr. Mawson in the workings connected with the Radium Hill Company's No. 2 shaft, but this part of the mine was inaccessible during the writer's visit to the field. It is possible that finely distributed pitchblende occurs scattered through the dense ferriferous and titaniferous lode matter ; but it cannot be definitely proven that the primary uranium contents exist in this form. In the cracks and crevices of the titaniferous iron ore which forms the bulk of the ore-shoots secondary uraniferous minerals are to be recognised. Of these secondary ores carnotite is most widely distributed, but autunite also was recognised in the ore mined by the Rare Metal Proprietary Mining Company at the northern end of the field, and the chemical investigation of the ore from this place has supported the recognition of traces of torbernite with the autunite.

These uranium-bearing minerals are almost invariably associated with titaniferous iron ore. Samples of the lode matter which showed the presence of hæmatite and magnetite in place of titaniferous iron ore were found to carry no uranium values. It appears that the greater part of the titaniferous iron ore is composed of the mineral ilmenite, which is normally a titanate of iron, but in which the proportions of iron and titanium are not constant. Magnesium in many specimens of ilmenite partly replaces the iron, and a number of varieties have been given separate names according to the amount of titanium present. The distinctions between these varieties are not well defined. With the ilmenite there occurs some mineral which gives an exceptionally high titanium content to some specimens. Rutile has been recorded

as occurring in the lode stuff, but the writer did not detect the presence of any rutile of normal character in the large bulk of ore examined by him. It is nevertheless possible that some ferriferous form of the mineral, such as ilmenorutile is present in small proportions, and that the black color of this species renders it indistinguishable from the more abundant ilmenite.

Samples of ore taken by the writer from various places show that hæmatite or a mixture of hæmatite and magnetite are sometimes the principal metallic ingredients of the lodes to the almost complete exclusion of the titaniferous iron ore. This is a noteworthy feature in view of the close association between the uranium values and the occurrence of titaniferous ore. It is therefore necessary that the ore should be chemically examined at frequent intervals during the progress of prospecting operations.

With these minerals that have been mentioned others are associated. Pyrite is present in small proportions and in the upper part of the ore bodies is found more or less completely converted into limonite. Traces of malachite and stains of an undetermined green mineral containing a small percentage of vanadium were detected in the writer's samples. The non-metallic minerals present in the lode matter are quartz and biotite mica. In fact the dark color of the schist, due to the presence of biotite, has proved, as far as exploratory work has yet shown, the best indication of the existence of mineralized zones in the schists and gneiss.

The mode of occurrence of the radio-active ore is not uniform throughout the field, and the following brief account is furnished of the essential features of occurrence. In the first place the surface indications, where these do exist, are either the actual outcropping of the harder and more resistant portions of the lodes which are well-defined, and which result from the actual filling of fractures with introduced material, or the distribution among the superficial alluvial deposits of fragments of iron ore set free from the lode-filled fractures and mineralized zones of schist. The fragmental ironstone is sometimes associated with quartz, but the existence of numerous fragments of unmineralized quartz is so universal throughout the whole region that, in the absence of iron ore, it cannot be regarded as an indication of the existence of valuable lodes.

The prospecting hitherto carried out has been restricted to the sinking and driving on the lodes which have been recognised at the surface. In the course of this work it has been proved that the distribution of the metallic minerals is somewhat irregular, and that shoots of ore may exist at a depth of 50ft. below the surface, even if no sign of lode matter can be detected on the apparent course of a lode formation at a point where an outcrop might be expected. For a similar reason it is found that other shoots of ore which afford promise at the surface diminish rapidly in depth. The metallic ingredients of the lodes in the district are, in fact, distributed through the lode formations in shoots of irregular form. The shoots contain bunches and lenses of iron ore which in some places weigh over a hundredweight, but which are usually much smaller.

The lodes are for the most part due to the selective mineralization of certain bands in the country rock. These lodes, where the relationship to the country rock could be deciphered, conform with the foliation of the rocks in their immediate vicinity. In a few places the ore bodies appear to have resulted from the filling of fissures with lode matter introduced in solution. The principal workings of the Radium Hill Company afford exposures of a lode which appears to be of this character. The form of the fracture has directly controlled the distribution of ore, and where, as at the northern end of these workings near No. 1 shaft, the fissure has been interrupted in its course by the existence of a resistant mass of amphibolite rock, the continuity of the ore has also been interrupted. It has been supposed that the lode has been dislocated by faulting at this place, but there is no evidence of the existence of a fault. The structural irregularity at the place referred to is due to causes which antedated the period of lode filling.

There appears, from the published reports on the various mining properties in this field, to be a general belief in the existence of a single well-defined lode traversing the several properties from end to end. There is no justification for such a view. In each property there are several lode formations represented, and it is not wise to attempt to establish the identity of one particular lode in one lease with a certain lode in another lease. For, in the first place, the intervening ground is, in some cases in which this continuity has been claimed, covered by extensive alluvial deposits which effectually conceal all signs of the lodes and the country rocks. In the second place there is no reason to believe that the identity of one lode formation with another implies similarity of mineral contents or values. The lodes in adjacent leases do in most cases possess a general parallelism of trend for the reason that they follow the foliation planes of the schist. But marked variations of strike are visible in the lode upon which most work has been done over so small a length as 200ft.

The general course of the lode formations is nearly north-east and south-west in the Radium Hill Company's leases, but in the South Australian Radium Proprietary Company's property the best defined formation has a north north-easterly trend. To the northward of these properties the structural features are less regular and present exposures do not afford much information as to strike. The dip of the lodes is in all cases to the south-east or east, and in most instances at steep angles.

The Valuation of the Radium Hill Ore Bodies.

A few remarks on some aspects of the uranium-radium market and upon other cognate matters concerned with these ores may be of interest at the present juncture. This is a question which is of paramount importance in connection with the exploitation of low-grade ores. In the discussion of the question, the demand for and the supply of the various constituents of the ore should be considered.

Radium.—The demand for prepared radium salts does not seem likely to diminish in the near future. The demand for radium preparations comes from physicists and from the medical profession. The scientific investigations which were commenced but a few years ago are still being carried on with unabating zeal in the principal laboratories in all parts of the world, and it is certain that this research will continue. While the scientific results which have been obtained from this world-wide interest in radium have the utmost basal importance, it is to be borne in mind that the direct application of radium to industrial ends has not yet been accomplished. With regard to the application of radium to medicine the case is rather different. The conclusions of C. L. Parsons, of the Bureau of Mineral Technology, United States Geological Survey, in this connection are deserving of close attention. In a recent paper on the "Uranium and Radium Situation" he has written:—"A recent report of the London Radium Institute, and the many articles emanating from minor laboratories experimenting in the application of radium to therapeutics all tend to show, however, that it has a real value, the certain application of which must await further experimentation. In the meantime no credence should be given to the many stories that are sure to be printed, unless they are backed up by the highest medical authority which will always give publicity with caution. The best medical authorities appear to agree that, up to the present time, radium has not been proved to be a specific for any disease, although it has been shown to be helpful in many cases. The outlook for its future application to certain diseases not easily treated otherwise is decidedly encouraging."

As regards the world's supply of ore, the following countries are the principal contributors, viz., Saxony, Cornwall, North America, and German East Africa.

The researches of the United States Geological Survey have recently proved that the principal producing country at the present time is the United States, the pitchblende and carnotite ores being obtained chiefly from Colorado and Utah.

In the paper by C. L. Parsons referred to above it is stated that much of the radium imported into America was prepared in Europe from crude ore exported from

America. Moreover, it is pointed out by Prof. Parsons that in the mining and dressing of the carnotite ores in America there is a very considerable waste. Experiments conducted by the Bureau of Mines with the object of preventing this waste are stated to have a fair prospect of success. This statement, when read in conjunction with the official conclusion that America " has exported carefully selected ores at a price by no means commensurate with their radium value if worked up at home," should lead to the establishment of a radium-refining industry in the United States that will profoundly affect the market.

It certainly appears that it is not wise for any country to export ore containing 2 per cent. of uranium oxide at the present market price of such ore. European buyers stipulate a grade of 2 per cent. uranium oxide, and the price paid for American ore of this quality is 75 dollars per ton (a little over £15 per ton) f.o.b., New York.

It has been found by actual experiment that in old and unaltered uranium minerals the ratio of radium to uranium is a constant. This ratio is technically known as the " equilibrium ratio " ; and, expressed in terms of familiar weights, means the presence of 320 milligrams of the element radium in every ton of the element uranium. If then this equilibrium ratio holds true for the ore under consideration it follows that each ton of ore containing 2 per cent. of uranium oxide contains 5·44 milligrams of the element radium, or about 9·3 milligrams of anhydrous radium bromide. Taking the value of radium bromide at £16 per milligram the gross value of the radium bromide in ore carrying 2 per cent. of uranium oxide is about £148 per ton. It is, therefore, not astonishing that there is an eager demand for ore of this grade at the rate of £15 per ton. The conclusions to be drawn from such figures are that either the cost of producing prepared radium salts is excessively high or that the producer is not obtaining a fair price for his ore.

The authority of Rutherford in this connection is of more than ordinary value. In his recent work, " Radio-active Substances and their Radiations," he writes as follows :—" The exceedingly high prices of radium at the present day (about £16 per milligram pure radium bromide) bear no relation to the cost of separation of the radium from the uranium minerals. The present price is artificial, and has resulted in part from the comparative rarity of deposits of pitchblende or of uranium minerals containing a fairly high percentage of uranium. The extensive use of radium for medical purposes, as well as for physical and chemical experiments, has so far absorbed the output. At the same time, the undoubtedly large profits to be realised at the present prices have led to a very careful search for uranium deposits in various countries. It is known that there are extensive deposits of low-grade uranium ores in various parts of the world, and it is to be hoped that in the immediate future methods will be devised of treatment of such ores. There seems to be no reason why the present abnormally high prices of radium should be ultimately maintained."

The establishment of the radium refinery in Sydney, N.S.W., by the Radium Hill Co., N.L., was due to the early recognition of the ratio of the cost of production to the intrinsic value of the ore, and it is to be hoped that this Australian enterprise will prosper in proportion to its merit.

The Radium Hill Company has published the cost of treatment at the Sydney works. This treatment cost is stated to be £19 10s. per ton, and the total cost, including mining, crushing, concentrating, and conveying the concentrates to Sydney are stated as £29 17s. 11d. per ton. At the present time it is announced that the stage of regular production has been attained. But hitherto the treatment has been confined to the ore from the Company's own mine at Radium Hill. It seems but a small step to the treatment in Australia of all the radium-uranium ores mined, and it is to be hoped that in the interests of Australian welfare the step will be taken.

It will be seen from the figures cited above that there is so wide a margin between the price paid for crude ore and the gross value of the contents of such ore that a

generous allowance may be made for depreciation in the market price of finished radium preparations and the cost of treatment. It is of course essential to remember that the values given are based upon the supposition that the radium bears to the uranium of the ore the equilibrium ratio, and that this ratio is known to be variable in the case of secondary ores such as autunite. The radium-uranium ratio has not, so far as the writer is aware, been determined for South Australian radium-uranium ores.

Uranium.—The compounds of uranium are not extensively used. Yellow opalescent glass and a yellow glaze on pottery derive their color from uranium salts, and a small demand exists for the manufacture of chemical re-agents. The utilisation of uranium in the manufacture of special steels has not been extensive on account of the fact that less expensive ingredients are claimed to give similar properties to the steel.

It will be found that, if no allowance whatever is made for the radium present in ore containing 2 per cent. of uranium oxide, the net value of that ore, at £15 per ton, for its uranium oxide only implies a price of about 6s. 9d. per pound for the whole of the oxide present in the ore. This price is certainly not above that which is quoted for small quantites. Hence it appears that the price now paid for radium-uranium ore is not above the present gross value of the uranium content alone.

Titanium.—Much attention has recently been drawn to the titanium contents of the ore from this district. It must be remembered that the oxide of titanium which is recorded in the assay returns from samples of the Radium Hill ore does not for the most part occur uncombined in the form of rutile. It has been indicated above that the greater part of the oxide of titanium occurs in combination with the oxides of iron in the form of minerals which are presumably ilmenite and ilmenorutile. While a demand is admitted to exist for the mineral rutile, it cannot be claimed that ilmenite, which is certainly the most abundant titaniferous mineral at Radium Hill, has an appreciable commercial value. Ilmenite is widely distributed among the iron ore deposits of the world, and is deliberately rejected as waste from those ores in which it is found, on account of the difficulties which it causes in the smelting of the iron ore. Its only application is to the manufacture of ferro-titanium for the production of titanium steel, and it appears highly improbable that the ilmenite at Radium Hill can compete with such deposits as those at Port Stephens, N.S.W., or Taranaki, N.Z., in the event of a demand for this mineral arising in Australia. Only in so far as the oxide of titanium can be separated and saved as a by-product from the treatment of the ore for uranium and radium can it be regarded as a possible source of revenue. Hence the value of the titanium oxide must be considered only as a contributory factor in the valuation of the ore which is being appraised also upon its radium-uranium contents.

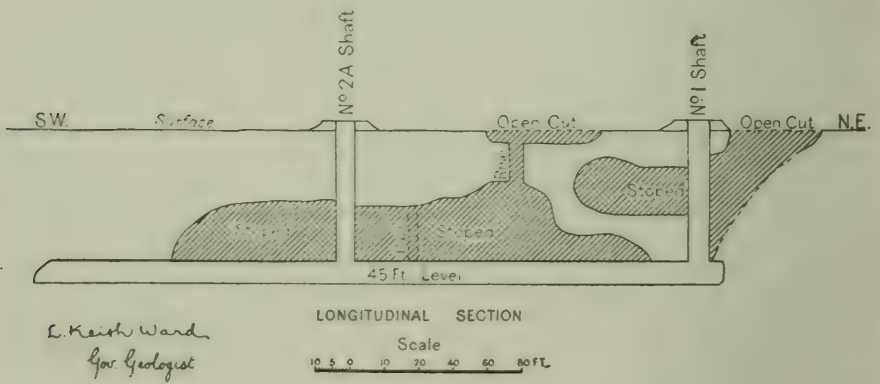
Other Metals.—The useful rare metals—thorium, chromium, vanadium, and tantalum—which are present in the ore occur in such minute proportions that they possess no direct value, and it remains to be proved that they can be concentrated in the by-products to such a degree as to pay for extraction. The other rare elements, viz., cerium, lanthanum, didymium, and yttrium, which have been recognised in the ore have at the present time no extensive application in the arts.

THE MINING PROPERTIES.

The Radium Hill Company, N.L., holds a group of 24 mineral leases of 40 acres each, so grouped as to extend in a N.E.-S.W. direction for a distance of two miles, and at right angles to this direction for a width of a mile or less. Almost all the

workings are situated centrally in this group of leases. Five principal shafts have been sunk, but it is by no means proved that these shafts are located on a single continuous lode. Of the five shafts only two could be descended at the time of the writer's visit. These two shafts are known as No. 1 shaft and No. 2A shaft, and provide access to the stopes from which the bulk of the ore mined and milled has been obtained. They are connected by a level 200ft. long at a depth of 45ft. below the surface, and almost midway between them there is a rise to surface from the stopes.

Almost half of the ore developed above the 45ft. level has been removed, and the necessity for deeper development is urgent. The writer was informed that deeper workings exist below the apparent bottom of the No. 1 shaft, but that these were filled in during the later stages of mining operations. Such a procedure cannot be commended as conducive to ultimate economy. The lode is thought locally to have been faulted by a disturbance at its N.E. extremity. The end of the ore-shoot was reached in the No. 1 shaft at the 45ft. level and appears at the surface 20ft. to the N.E. of the shaft. It is elsewhere indicated that the writer holds the opinion that no fault exists at this place, but that the continuity of the fracture which has been filled with lode material was interrupted prior to the introduction of the ore. Evidence of the splintering of the lode-filled fracture is afforded by the "horse" of mullock in the lode at the bottom of No. 1 shaft, where a block of lode stuff has been left standing. The structural details to the N.E. of the shaft have been concealed by the filling of the stope with waste; but in the open cut above this stope vein-stuff may be seen penetrating the amphibolite rock beyond the limits of the main shoot.



The Main Workings, August 22nd, 1913.

RADIUM HILL MINE.

To the S.W. the lode has proved continuous as far as the drive extends, 90ft. from No. 2A shaft, though the ore at this end of the workings does not appear quite as good as that in the vicinity of No. 1 shaft. The back of the stope to the S.W. of No. 2A shaft is 24ft. above the shaft bottom, and extends for a horizontal distance of 50ft. from the shaft; but for this stoped block the ore body is intact to the S.W. of No. 2A shaft. The average width of the lode is between 4ft. and 4ft. 6in.

No. 2 shaft is distant 204ft. from No. 2A shaft, and from it work has been carried out in a N.E. direction. The shaft and these latter workings were inaccessible, and it is not possible to discuss the geological features of this part of the mine.

The same reason must be given for lack of satisfactory data with regard to No. 3 and No. 4 shafts, which are distant respectively 11½ chains and 22½ chains from No. 1 shaft.

There are, however, surface indications which point to the existence of other lodes in the immediate vicinity of No. 3 shaft than that on which the shaft has been sunk.

The exposures are insufficient to justify the assumption that all of these workings are located on the same lode. The lack of detailed information at these points renders it impossible to form an estimate of the total reserves of ore in the mine.

A little prospecting on the E. boundary of the leases has proved the presence of traces of carnotite, but these indications have not been followed in depth.

The ore is concentrated in the first place by hand-picking, and afterwards by a plant which is producing 10 tons of concentrates from every 35 tons of ore milled. The mill is furnished with a jaw cracker and rolls, whence the ore is elevated to a trommel with 12 x 1 millimetre slots. The oversize from the trommel passes back to the same rolls, and the ore which passes through the trommel is conveyed by a belt to a bin feeding three magnetic separators. The concentrates are freed from the biotite which accompanies them by a simply constructed blower.

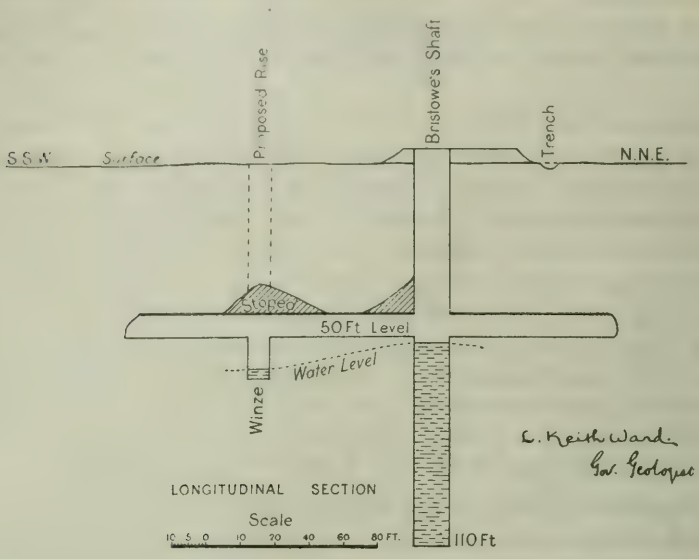
A new concentrating mill of proper design is required, and first-class work cannot be expected without radical alterations and renewals in the existing plant. It does not appear to the writer essential that dry crushing and magnetic concentration be employed, but this method possesses obvious advantages in a region of low average rainfall. While it is admitted that the question of the metallurgical treatment of the concentrates has hitherto been of the greatest importance to the Radium Hill Company, it should be pointed out that the first condition for the future well-being of the whole enterprise as at present conducted is a sound policy of underground development. The information obtained by the writer from the accessible workings points to the desirability of sinking the No. 2A shaft without delay.

The South Australian Radium Proprietary Company, N.L., holds a group of 13 mineral leases of 40 acres each. These are located immediately to the N.E. of the Radium Hill Company's leases, and extend in a N.E. direction for a maximum length of a mile and a half.

The principal workings are situated in the S. part of M.L. 917, where four shafts have been sunk and some superficial excavations made.

The principal workings are those in connection with Bristowe's shaft, which has been sunk to a total depth of 110ft. At the time of the writer's visit drives had been extended at the 50ft. level in a N.N.E. direction for 52ft. and in a S.S.W. direction for 90ft. This drive is on a mineralised zone of which the average width is about 2ft. 6in. At a distance of 50ft. from the shaft the S. drive met with ore containing carnotite, and a winze was sunk to a depth of 12ft. on this ore. A short stope above the level at this place has proved the upward extension of the carnotite bearing lode stuff, although there is no outcrop at the surface above the site of the shoot. It is proposed to rise to surface at this point. The main shaft is full of water to a depth of 52ft. from the surface. It should be unwatered, and a drive should be carried along the lode formation in a S.S.W. direction to try and prove the downward extension of the carnotite-bearing ore located at the 50ft. level.

Samples taken by the writer show that the iron ores present in these workings do not contain a constant proportion of uranium oxide, and that the ore which contains visible carnotite is of much the highest grade.



The Main Workings, August 25th, 1913.
SOUTH AUSTRALIAN RADIUM PROPRIETARY MINE.

Hutton's shaft, situated 5½ chains to the N.N.E., and probably on the same formation as that on which Bristowe's shaft is located, had been sunk to a depth of 18ft. at the time of the writer's visit. The iron ore at this place carries a small proportion of uranium oxide.

To the W. of this formation there are two other shafts which have proved the presence of mineralised zones, with an outward appearance similar to that exposed in the principal workings. Picked samples of the iron ore from these places were taken by the writer, but proved on assay to contain no oxide of uranium, and only traces of titanium dioxide. The iron minerals proved to be haematite and magnetite. The same results were obtained by assaying picked iron ore from a hole 6ft. deep on a formation near the N.W. boundary of M.L. 917.

At the N. corner of M.L. 916 some work has been done, and two shafts have been sunk, but without proving the existence of ore of appreciable value. The picked samples taken by the writer proved, on assay, to contain no uranium oxide.

The Rare Metals Proprietary Mining Company, N.L., holds at the present time several mineral claims at the N. end of the field, and on three of these, viz., 9279, 9549, and 9550, shafts have been sunk. Near the S.E. corner of claim 9279 there is a shaft 38ft. in depth on a narrow zone of mineralised schist carrying carnotite, ilmenite, and some mineral such as ilmenorutile containing a high proportion of titanium dioxide. A small parcel of ore from this locality has been exported. The most promising discovery, however, has been made half a mile to the S.S.E. A shallow prospecting shaft afforded an exposure of ilmenite carrying autunite and traces of torbernite, and a vertical shaft was begun at a distance of 25ft. from the prospecting shaft. This shaft, known as Taylor's shaft, passed through a very promising lode at a depth of 20ft. from the surface. The formation dips to the N.E., and it is intended to crosscut in that direction at a depth of 70ft. from the surface. The bottom of the shaft was nearly 40ft. below the surface at the time of the writer's visit. It is proposed to explore the lode at and below the 70ft.

level, and, if developments warrant it, to sink a main shaft at some point to the N.E. The plans for deeper development and for concentrating the ore from the lode-formation should not be too definitely formulated before the prospecting work at the 70ft. level has been carried out.

At a distance of 18 chains from Taylor's shaft some work has been done in the S. part of claim 9549 upon a formation rich in octahedral crystals of magnetite. The matrix is for the most part mica schist, which immediately overlies bedded quartzites. The magnetite-bearing mica schist has been exposed in two shallow pits, and is associated with pale-colored amphibole schist also carrying crystals of magnetite. Green stains of copper carbonate occur on the foliation planes and cleavages of this schist, but the excavations are not sufficiently deep to afford an indication of the structure of the formation or of the character and grade of the unweathered ore. An exposure of similar material has been effected by trenching on the W. slopes of Bonython Hill in claim 9550. The formation may possibly be continuous beneath the alluvial which covers the surface between these two places. The mineralogical constituents of the formation, when considered together with the geological structure, suggest the idea that the malachite results from the weathering of a highly altered argillaceous limestone which has been impregnated with copper.

Iron ore associated with biotite schist has been located at several points to the N.W. of Taylor's shaft, but very little has yet been done upon these outcrops.

Prospecting work outside the limits of the holdings of the three companies mentioned above has not hitherto proved successful. In claim 9577, immediately to the N. of the South Australian Radium Proprietary Company's lease 914, a shallow shaft has been sunk, and more recently some shallow pits excavated. Picked samples of the iron ore exposed in these workings gave, on assay, no trace of uranium oxide and only a trace of titanium dioxide, the iron-bearing minerals being haematite and magnetite.

At a point half a mile to the N.W. of the Radium Hill Company's main workings a shaft has been sunk in claim 9591, and some trenches have been cut in claim 9590. There is at this place a zone of biotite schist carrying small amounts of iron ore, the general trend being apparently N.E. and S.W.

A similar distance to the S.E. of the Radium Hill Company's main workings a little shallow trenching has been done, but no discoveries of importance have been made.

To the E. of the area containing the radium-uranium lodes a group of five claims has been recently allotted to a party of prospectors who have carried out a considerable amount of work. A quartz reef in the "Doughboy" claim has been partly exposed. A sample of the ironstained part of the quartz from the outcrop was assayed and found to contain neither gold nor silver. To the S.E. of this quartz reef there is a small outcrop of garnetiferous mica schist in a small creek bed. The principal shaft is located in the S.E. part of the "Wonder" claim, and had reached a depth of 18ft. at the time of the writer's visit. The rock penetrated by the shaft is mica schist traversed by pegmatitic dykes. Another shaft, 1 chain distant from the latter, has exposed amphibolite rock, the joints in which are stained here and there with carbonate of copper. No signs of a defined copper vein were seen at this place. To the W. of the shaft and 9 chains distant from it some trenching has been done. Massive fragments of iron ore consisting of an admixture of magnetite and hæmatite are exposed in this trench. A sample of this ore was assayed and found to contain no uranium oxide. Through this group of claims runs a remarkable belt of staurolite schist, staurolite-cyanite schist and cyanite schist, but no indications of any ore bodies of commercial value were detected. In the absence of these indications no recommendation can be made in support of the work now in progress.

Conclusion.—It appears from the consideration of all aspects of the position that there has been established in connection with the Radium Hill district a branch of the mining industry which possesses the elements of success and possibilities of expansion; but the grade of ore treated is lower than that which can now find a market elsewhere in the world. Due credit must be given to the Radium Hill Company and its metallurgist for this achievement; but it must be remembered that the present standard grade (2 per cent. of uranium oxide) specified by foreign buyers may be lowered under stress of competition.

At the present time only the Radium Hill Company has actually reached the producing stage, but there are indications of a promising nature in the workings of both the South Australian Radium Proprietary Company and the Rare Metal Proprietary Mining Company. These latter mines may, when further developed, be in a position to ship ore of marketable grade, but the ore of appreciable value that can be said to have been already proved is exceedingly small in quantity.

From what has been stated above with regard to the variability of the character of the lode minerals from point to point it will be apparent that the work of prospecting must be controlled by frequent assays. It is already sufficiently established that the iron ore is not always mainly ilmenite, but that in the absence of oxide of titanium the predominant mineral is sometimes hæmatite. Where secondary minerals such as carnotite are not recognisable in the ore, assaying is quite indispensible.

It has been indicated above that the metallic shoots are irregularly distributed in the lode formations which are formed by the replacement of certain bands of the country rock. It therefore follows that the value of any such lode can only be judged by systematic development. It is not to be considered that the termination of a bunch of ore is the mark of the limit of the lode formation. Another bunch of ore may be distant only a few feet from the site of that which has been completely removed.

Existing exposures within the area with which this report deals do not indicate the presence of lode matter of commercial value other than that which carries uranium oxide. The recovery as by-products of other metals than uranium and radium may possibly assist to defray the cost of mining and treatment, but it does not appear probable that a market will be found at the present time for ore which is of lower grade than the standard specified by buyers of uranium ores.

All of the uranium-bearing lodes are in the very early stages of development; and it would appear, from the reported solution of the problems of treatment of the ore from this field, that the amount of ore hitherto shipped will prove small by comparison with the production of the next few years (7 10-13). (*Vide* also Record, page 361, Reviews Nos. 10 to 18, and Bulletin on radio-active ores, October, 1911.)

REPORT ON THE DELORAINE GOLD MINES, N.L.

LOCALITY—MOUNT LOFTY RANGES.

In accordance with instructions given by the Hon. the Minister of Mines, the writer made an examination of the Deloraine Gold Mines, N.L., on November 19th with the object of furnishing a report on the mode of occurrence of the ore in that mine.

The mine is situated in the central part of the hundred of Para Wirra, at a distance of about a mile to the eastward of the main road from Chain of Ponds to Williamstown. The sections within which the mine is situated, viz., sections 1548, 1602, and 2 of Para Wirra, are freehold property.

The area in the vicinity of the mine workings is underlain by slates of variable grain. These have been fractured, and the filling of the fissures have produced the lodes. In the vicinity of the lode-channels there has been some alteration of the slates with the development of sericite. The country rock also shows disseminated pyrites where it is exposed by crosscuts which penetrate the zone of oxidation and leaching alongside the lode-matter. The structural features of the lodes give evidence of relative displacement of the two sides of the lode fissures.

The underground work hitherto carried out has been almost wholly restricted to development and mining at two places, which are referred to in this report as the northern and southern workings respectively.

Northern Workings.—The main shaft has been sunk to a depth of 200ft., and levels have been driven northwards and southwards at 109ft. and 192ft. from the surface. The shaft is vertical for the first few feet and then follows the underlie of the lode, which dips to the eastward at angles of between 49 degrees and 65 degrees. This shaft proved to have been sunk through the best shoot of ore yet located. In the northerly drives at both levels the ore gave out at very short distances from the shaft, although the latter was sunk for its whole depth in good ore. The southerly drives and the stoping that has been carried out show that the main shoot of ore upon which most of the work has been done has a steep southerly pitch between the surface and the 192ft. level.

A very characteristic feature of the lode is the variation in the strike. The several portions of the lode possess strikes which bear up to 10 degrees on each side of the magnetic meridian, but the continuity of the lode is not broken. As a whole the lode has a course which is very nearly north and south.

These marked variations in the strike and dip of a lode are by no means unusual. They are found to occur wherever a lode-fracture has a somewhat irregular course, and relative displacement of the two sides of the fissure occurs. The lodes which result from the filling of such fractures are characterised not only by variations in strike and dip, but also by varying thicknesses of ore—a feature which is very noticeable in the Deloraine Mine. These several variations must not be regarded as signs of disturbance of the lode at a date subsequent to the period of ore deposition, and in the further development of the lode the track of the ore channel must be followed carefully, even of the lode-filling pinches out altogether in places. The "makes" of ore will be located wherever a suitable conduit has been formed for mineralising solutions, and bulges in the ore body will be found to give place to mere traces of the lode channel if the unprospected portions of the lode fissure are similar to those portions exposed in the existing workings.

Three short prospecting crosscuts have been put out to the east and west of the southern drive on the 109ft. level, so far without positive results. It will probably be a wiser policy at the present time to restrict the work of crosscutting to those places where the lode is exceptionally wide, as, for example, at a point 20ft. from the face of the southerly drive at the 192ft. level. There is at the present time no certain indication of the branching of the lode in the main workings, but a sufficiently long crosscut should be put in to prove the full extent of the lode at the place referred to.

The width of the lode varies from point to point. To the north of the main shaft it is about 2ft. In the stope above the 109ft. level it is from 2ft. to 3ft. wide, and in the stope above the 192ft. level it is from 3ft. to 4ft. in width. To the south of the stope above the 109ft. level the lode becomes so narrow at one point that it is represented by a veinlet only half an inch thick. From this point it widens to as much as 2ft., and near the face a short stope has been carried for a few feet in length to a height of 12ft. above the level. The body of stone in the lode at the southern end of the 192ft. level southerly drive is much larger, exceeding 5ft. in width at a point 20ft. from the face.

The ore standing above water level is a somewhat cavernous quartz, containing traces of copper pyrites and more commonly chalcocite, covellite, and native copper,

together with limonite and bunches of barytes. The ore from the lowest level in the mine still shows marked signs of oxidation, but iron pyrites is present in addition to copper pyrites. It is found that gold values are highest where the copper sulphides—especially covellite—are most abundantly developed. The association with covellite probably indicates some secondary enrichment of the gold at or near the water level.

The proportion of metallic minerals present in the lode has not yet been determined for this deep-level ore by concentration at the mine, since the ore milled has been obtained from different parts of the mine and mingled in the battery bin. As a whole the ore hitherto treated contains from 2 per cent. to 4 per cent. of concentrates and a still higher percentage when pockets of barytes are encountered.

The distribution of gold in the lode matter is not regular. The best shoot of ore is that through which the main shaft passed for its whole depth. The shaft is situated near the northern end of the shoot, and the main body of stone crushed has been won from the stopes on the southern side of the shaft. The values obtained in driving the southerly drive at the 192ft. level proved disappointing, but the stope at a height of 15ft. above this level produced ore of good grade.

Southern Workings.—At a distance of 546ft. from the main shaft is the No. 7 shaft. The position of this shaft is approximately on the line of the lode worked from the main shaft, but the connection between the lode on which it is sunk and the main lode is not proven. To the south of No. 7 shaft a drive at the 60ft. level has proved the course of the lode to be approximately north and south, with small variations such as have been mentioned in the case of the main lode. But to the north of No. 7 shaft the lode appears to bend round gradually until it acquires a strike of 42 degrees west of north.

This north-westerly lode has been followed in a shallow tunnel which connects with the No. 7 shaft, but work has not yet been carried far enough to show conclusively whether this is a branch of the main lode or not. It is possible that the lode exposed in the main workings does not extend southwards as far as No. 7 shaft, and that the southern workings have exposed a simple lode, the northern end of which is bent round to the westward. This matter can only be definitely proved by extending the main workings southwards, or the No. 7 north drive towards the main shaft. If the latter course is adopted a short north-easterly crosscut should be put out at the present position of the face of the drive which has already acquired a bearing of 15 degrees west of north. It appears to the writer preferable to drive southwards from the main workings.

To the south of No. 7 shaft there is a short stope above the 60ft. level in which the lode has a width of 20in. From the shaft to the southern face of the drive the width of the vein is between 20in. and 24in., and the values are stated to be between 9dwts. and 1oz. of gold to the ton. The character of the ore is on the whole similar to that of the oxidised ore of the main workings.

To the south of these workings there is a little lode-stuff outcropping for a distance of a few yards, but beyond that point the outcrop is lost beneath the alluvium of Deloraine Creek, which appears to follow the course of the lode.

Treatment.—The ore is crushed in a five-head battery of 600lb. stamps, and the pulp passes through a 30-mesh screen to amalgamation plates and a Card table. The concentrates are sold to copper smelters and the tailings are stacked below the mill. The copper contents of the concentrates have been as high as 11·47 per cent., and the gold contents as high as 12·74 ounces per ton, but these are the maximum figures, and the average value is lower.

The tailings, of which some 2,000 tons are already stacked, are estimated to carry from 3dwts. to 5½dwts. of gold per ton and 1·5 per cent. of copper. The bullion from the tables is found to carry very little silver, but the native copper in the oxidised

ore amalgamates with the quicksilver and makes the process of refining the bullion rather tedious and expensive. At the present time the battery is treating from 160 to 170 tons of ore per month.

The details regarding metal production from the mine up to April 30th, 1913, have been published in Review No. 18 of Mining Operations in the State of South Australia. Supplementary to these published figures is the following statement of production for the six months ended October 31st, 1913 :—

Amount of ore treated	959 tons.
Amount of concentrates produced	21·6132 tons
Gross value of gold recovered	£2,596 6s.
Gross value of copper recovered	£100 7s. 2d.

This statement does not take into account some eight tons of concentrates which were on hand or in transit on October 31st, 1913, but includes the concentrates which were on hand on April 30th, 1913.

Conclusions and Recommendations.—The Deloraine Mine presents no abnormal features which might hamper the progress of developmental operations. The two lodes which have been worked may be followed without hesitation beyond the limits of existing workings. The connection between them, if such exists, will be revealed by the extension of prospecting drives—preferably in a southerly direction from the northern workings.

It appears to the writer advisable to have an accurate survey of all existing workings made. This is the more desirable on account of the numerous deviations in the strike and dip of the lodes. A plan will also afford a means of keeping a permanent record of assay values and widths during the progress of development.

The lode matter as far as it has been exposed is of payable grade, but the average width is small and the total amount of ore blocked out is consequently not large enough to justify the erection of a large battery. Nevertheless the present rate of mining, which is limited by the small capacity of the existing battery, might reasonably be increased. If this step is taken it will be essential to push on with the work of development in depth. The southern workings are still wholly above water level, and the main workings have not yet reached such a depth as to afford exposures of unoxidised ore. It would be unwise to defer the prospecting of the deeper portions of the vein-matter until the more easily won ore has been entirely removed.—(4–12–13.)

(*Vide* also Reviews Nos. 10, 13, 14, 15, 16, 17, and 18.)

ALUNITE IN SOUTH AUSTRALIA.

LOCALITY—MOUNT LOFTY RANGES.

Locality.—The south-western portion of the hundred of Myponga was visited on November 20th and 21st, in accordance with instructions received from the Honorable the Minister of Mines, for the purpose of making a geological examination of the recently discovered deposit of alunite in that district. The area with which this report is concerned is that portion of the coastline of South Australia which is in the immediate neighbourhood of Carrickalinga Head, a little less than four miles to the north of Normanville.

Geology.—The country rocks within which the alunite veins occur are interbedded slates and limestones of Cambrian age. These rocks, although rather disturbed in the immediate vicinity of the veins of alunite, have a general dip to the westward.

At Carrickalinga Head the strike, if minor variations are neglected, is nearly meridional; but half-a-mile to the southward the reefs outcropping on the shore have a strike of N. 40° E., and a dip to the north-west at 63°.

There is a capping of travertine limestone on the Cambrian slate and limestone at a short distance inland at Carrickalinga Head. This capping completely covers the underlying rocks, and is sufficiently thick to mask the alunite veins if they do extend over a greater width than is now apparent.

The principal discoveries in this vicinity have been made in section 265, hundred of Myponga; but there are three other points about half a mile to the southward, in section 1025, where small veins containing alunite outcrop.

The general trend of the zone within which the known veins of alunite near Carrickalinga Head are included is slightly to the east of north.

Mineralogy.—The mineral alunite, with which this report deals, is a hydrous sulphate of aluminium and potassium, the formula of which may be written $K_2O.3Al_2O_3.4SO_3.6H_2O$. The alunite found at Carrickalinga Head is of exceptional purity, and where unaltered by weathering, is snow-white. It occurs in compact micro-crystalline aggregates and breaks with a conchoidal fracture. A freshly-broken surface has the appearance of unglazed porcelain. The mineral is brittle and massive specimens are easily broken into fragments. The action of weathering causes softening and disintegration, and weathered specimens are yellowish in color. A notable feature of the weathering is the fact that it proceeds inwards from the edges and corners of the veins in such a manner that spheroidal blocks of ore are found immediately below the surface. The rounding is due to gradual weathering *in situ*, not to attrition.

A few specimens were taken from each exposure at Carrickalinga Head and were bulked together to form an aggregate sample of the picked veinstuff. This bulk sample was analysed by Mr. W. S. Chapman, departmental analyst, and was found to contain:—

Sulphuric anhydride	35·81
Alumina	34·90
Ferric oxide	0·64
Lime	Minute trace
Magnesia	Minute trace
Potash	10·36
Soda	1·12
Water at 100° C.	2·25
Water above 100° C.	13·74
Silica	0·66
Phosphoric anhydride	0·28
Chlorine	0·55
	100·31
Less oxygen equivalent to chlorine	0·12
	100·19

Mode of Occurrence.—The alunite occurs in complex vein-systems which are only partly exposed in the excavations that have been made. The component veins of the vein-systems vary in thickness from an inch or less to an observed maximum of 3ft. The veins strike and dip in all directions, their orientation being dependent upon the fracturing at the immediate place in which they are developed. Each group of veins constitutes what is commonly known as a stockwork, that is to say, an assemblage of veins traversing a shattered rock mass in all directions. In the case of the alunite-bearing stockworks under discussion the veins are small, and

the blocks of country rock are so intimately distributed among the veins that both vein-stuff and barren country must be mined together. Samples were taken of both slate and limestone country rocks from portions of the stockworks immediately alongside the veins. These samples were analysed and found to contain no traces of alunite. It appears, therefore, that the country rock included within the limits of the vein-systems must be wholly rejected as waste.

There are several of these stockworks partly exposed and each appears to strike as whole in a direction bearing about 30 degrees east of the magnetic meridian; but the belt or zone which contains the principal vein-systems has a course which is nearly meridional. This zone within which the chief prospecting work has been carried out is situated in section 265, hundred of Myponga, and extends for a length of 10 chains, and a width of about two chains. It is, however, essential to remember that these dimensions refer only to the dimensions of the area within which the principal known veins are situated, and that the vein-matter itself only occupies a small fraction of this area.

No other mineral has yet been found immediately associated with the alunite, but two narrow veinlets of calcite were observed occurring separately in the vicinity of the alunite veins.

Many of the known deposits of alunite in various parts of the world have been investigated by geologists, and the conclusion has been arrived at with regard to most of them that they have been formed by the action of sulphurous fumarolic vapours upon felspathic rocks. Within recent years, however, it has been shown that this explanation with regard to the genesis of the mineral is not applicable to some occurrences. It is now known that alunite is found also as a constituent of mineral veins, and that in some cases, at least, it has probably been introduced by solutions of deep-seated origin. To this latter class the deposits at Carrickalinga Head belong since a proximate source for the potassium of the alunite is not apparent.

Prospecting.—The existing exposures are insufficient to show the proportion of alunite vein-stuff to country rock in the several stockworks, and it should be the first work of the prospectors to ascertain this proportion. The vein-system, which has at the present time the most promising appearance, is one which has been found at the top of an exceedingly steep gully which leads straight down to the sea at a point immediately to the north of Carrickalinga Head. Facilities for cheap working exist at this place as the disposal of waste will be very easy, and open cuts may be made along the course of the vein system in both north-easterly and south-westerly directions. At the present time it can hardly be definitely stated how wide the face of the open cut must be made, as further work may prove a lateral spreading of the vein-stuff beyond the limits now apparent. The measurement of the excavation when thus opened up, and the knowledge of the amount of alunite recovered during the work will give the data necessary for computing the proportion of alunite in the vein system. The other discoveries in the immediate vicinity of this locality can also, in the earlier stages of prospecting, be opened up by open cast workings.

In the search for other veins than those already known to exist the general trend of the zone bearing the vein systems should be borne in mind rather than the trend of any particular veins or group of veins.

Commercial Application.—Alunite is a mineral from which different substances of commercial value may be obtained, according to the treatment to which it is subjected. In the past alunite has been utilised chiefly for the production of potash alum, and aluminium sulphate. But within recent years attention has been drawn to the possibiltiy of using the mineral as a source of potash fertilisers. According to the degree of calcination to which alunite is subjected either potash alum, or potassium sulphate may be generated and recovered by leaching with water.

Salts of potassium are desired for use as fertilisers in agriculture, and the high prices paid for potash fertilisers has led to a review of all possible sources of potassium. Alunite has been considered in this connection and experimental work carried out in the United States has indicated its possible application.

In one series of experiments it has been found that from 100 parts by weight of raw alunite it is possible to recover 17·9 parts by weight of potassium sulphate by igniting the powdered mineral and leaching the residue with water. The residue after leaching is alumina, the purity of which is dependent upon the purity of the alunite selected for the test.

Suggestions have also been made that it may be more practicable from an economic standpoint to use ignited alunite directly as a fertiliser, on account of the difficulty of completely leaching out the sulphate of potassium after ignition. Cultural tests have been made with wheat which show that the effect of ignited alunite is about the same as that of potassium sulphate and greater than that of potassium chloride when amounts of these substances containing equivalent quantities of potash are added to soils. Raw alunite, according to similar tests, has a beneficial effect upon plant growth, but the results are not nearly so good as those obtained from the ignited mineral.

The chief problem for consideration by those interested in the exploitation of alunite is that which concerns the form in which it is to be marketed. It appears probable that a market will be found for crude alunite of such purity as that which has already been exposed. The estimated value of the crude mineral is about £3 15s. per ton, according to the most recent figures available; but it does not follow that so high a price can be obtained by sellers of the crude ore to manufacturers of the salts to be derived from it. If on the other hand the mineral is to be treated locally and converted into saleable products there are several matters to be considered. It will be necessary to decide what products will be manufactured, and in this connection the markets for the possible derivatives must be considered.

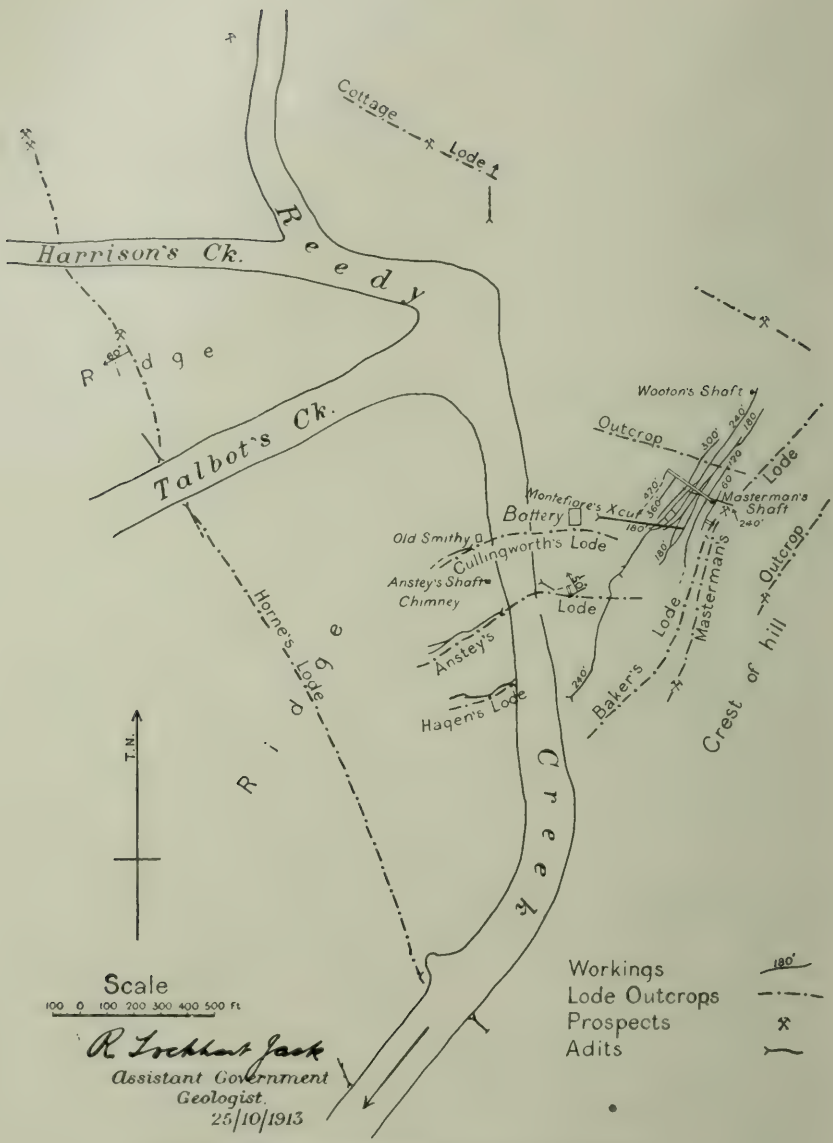
It is doubtful if at the present time the Australian consumption of potash alum, or aluminium sulphate is sufficient to absorb even a relatively small output, hence the cost of carriage to centres at which textile or paper-making industries are situated must be taken into account.

If it be decided to manufacture sulphate of potassium it must be remembered that the present local retail price (£14 per ton) of that substance is about double that of the value of potassium sulphate according to the estimated values quoted in German export or American import statistical returns.

The Australian demand for potash fertilisers is not at present large, and it is not considered likely that this demand will increase rapidly in the near future. Hence, if the alunite deposits prove sufficiently extensive to admit of the preparation of potassium sulphate on a large scale the cost of placing this product on European or American markets must be considered.

If the potassium sulphate is leached out of the ignited alunite the residue of aluminium oxide may be found to have some commercial value. The metal aluminium has not in the past been prepared from the anhydrous oxide for the reason that the hydrated oxide bauxite has been less expensive; but it is considered by American writers that the alumina to be recovered from ignited alunite may be regarded as a by-product saleable to aluminium smelters for reduction to the metallic form. Should the ignited alunite be used directly as a fertiliser without leaching, any value that the aluminium oxide may possess must of course be discounted.

From these statements it will be evident that the commercial availability of alunite must be carefully considered from several standpoints, and that the owners of the deposit must decide between the choice of selling the crude ore outright and that of manufacturing one or more of several products, all of which must compete on the world's markets with the manufactured or natural products of other countries.



Sketch, based on an old plan, showing:–
The lodes in the vicinity of

KITTICOOLA

To face page 43.

Conclusion.—The alunite which has been exposed is of high quality, and the success of the enterprise will very largely depend upon the quantity of vein matter available and the proportion of vein stuff to country rock in the stockworks. Working expenses during the earlier stages of prospecting should not be high, and the distance from the jetty at Normanville is only about four miles. The alunite should be bagged at the workings as soon as it is mined. Every care must be taken to keep working costs down to the lowest possible limit as the intrinsic value of the alunite is not sufficient to allow a wide margin of profit.—(8–12–1913.)

REPORT

BY

The Assistant Government Geologist (R. Lockhart Jack, B.E., F.G.S.).

REPORT ON THE KITTICOOLA MINE.

HUNDRED OF TUNGKILLO.

LOCALITY—MOUNT LOFTY RANGES.

The Kitticoola Mine, owned by the Port Lincoln Copper Company, is situated on the E. slopes of the Mount Lofty Ranges, 2 miles by road from the township of Palmer and 43 miles N.E. by road from Adelaide.

The workings are entered from the gorge of Reedy Creek, the lode outcropping in a hill about 250ft. above the level of the creek, towards which it dips in a N.W. direction.

The mine is situated in a belt of gneissic granite about three-quarters of a mile in width, with the foliation showing a dip to the W.N.W. of about 40° to 60°. Above, or to the W. of Horne's lode mica schists, and what appears to be a thin-bedded quartzite are developed.

Two vein systems are visible, one in a general N.N.W. to N.E. direction, includes Horne's lode on the W., the lode or group of lodes on which the main workings have been made, and an unnamed outcrop 290ft. to the E. of the main workings, and on which only a little surface work has been done. They all have a W. dip. The other system is approximately at right angles and appears to be confined longitudinally between Horne's and the main lode. Five lodes are known in this system, four of which have been worked for gold or copper.

They all dip to the N., and as they approach the W. member of the main lode series swing round to the N.E. and lie against the hanging wall of the lode. It is probable that they have had an influence upon this lode, and are the cause of the N. pitch of the shoots of richer ore.

A good deal of confusion appears to have arisen as to the nomenclature of the various lodes, so that it is perhaps advisable to describe their occurrence. According to a plan made by John Phillips in 1849 Horne's is the extreme W. lode of the N. and S. system and has a general W.N.W.-S.S.E. strike, and a dip of about 60° to the W.S.W. A considerable amount of exploratory work has been done upon it at intervals over a distance of more than 3,000ft. on the W. or right bank of Reedy Creek.

The main workings were then known as Baker's Lode; S. of the adit (Montefiore's), on the 180ft. level of these workings and S. of an old smelter chimney on the right bank, the plan shows Anstey's lode, one of the E.W. series. A considerable amount of work had been done upon it including a vertical shaft. Its

extension to the left bank of the creek was then known as the " New Discovery Lode." On the latter a drive was subsequently carried in 278ft. towards the 240ft. level of the main workings, in which the junction of this lode may be seen.

South of this again is a small lode known as Hagen's.

At a later date the " Cottage " lode, running from a point 3 chains N. of Wooton's (the N. shaft on the main lode), on a bearing of N. 60° W. past the manager's residence and across Reedy Creek, was worked for gold, a crushing plant having been erected upon it.

Still more recently Cullingworth's lode was opened up N. of Anstey's lode and immediately S. of the old smith's shop on the W. side of the creek. Its E. extension may be seen near the S. end of the present battery and in the 180ft. adit immediately to the W. of Baker's lode.

Between Cullingworth's and the Cottage lodes a strong vein of quartz, with limonite and specular iron, is to be seen on the surface 120ft. N.E. of the main or Masterman's shaft, but no work has been done upon it. Its probable downward extension was observed at a point in the 180ft. level 220ft. N.E. of the shaft. A sample taken from the outcrop yielded on assay 1dwt. of gold per ton.

Mr. Brown, reporting in 1899, names the tunnel and shaft on Anstey's lode, " Baker's," and since then the impression seems to have arisen that this lode, which junctions with Baker's lode at the 240ft. level, is Baker's, and in some instances it has been so referred to.

The main workings shown in the old plan as being on Baker's lode have been subdivided in Mr. Brown's report into Baker's lode on the W. and Masterman's on the E. The latter is now also referred to as Lowe's. Beyond it to the E. is a small lode junctioning to the S. on the 180ft. and 240ft. levels that is known as Critchley's. It is only separated from Masterman's by a few feet of country, and is reputed to have yielded bunches of rich copper ores.

At the time of the writer's visit to the mine the water level was a few feet below the 240ft. drives, and only the workings in the oxidised zone could be seen.

Reports by Mr. H. Y. L. Brown, lately Government Geologist, and by the Inspectors of Mines throw considerable light upon the values of the lower levels, more especially as no great quantity of ore appears to have been extracted from these workings since their reports were written.

The following information has been collected from these and other sources :—

Three Hundred Feet Level.—Mr. Brown, when reporting on the Kitticoola Mine, in 1899, took nine samples over the full width of the lode, for a distance along the lode of 90ft. The gold varied from 18dwts. to 1dwt., averaging 6dwts. 16grs., while the copper varied from 30 per cent. to $\frac{3}{4}$ per cent., and averaged 5·47 per cent.

In the " Review of Mining Operations, No. 8 " (1908), the company furnished a report to the effect that the average values of the lower levels were 6dwts. of gold and $2\frac{1}{4}$ per cent. of copper.

Three Hundred and Thirty Feet and 360ft. Levels.—Mr. Brown, in 1899, took 11 samples over a length of lode of 235ft. and the full width of lode. Gold ranged from 12dwts. to 2dwts. per ton, and averaged 6dwts. The copper varied from $4\frac{1}{2}$ per cent. to $\frac{1}{4}$ per cent., and averaged 2 per cent. He also took six special samples, or samples over portions of the lode and not over the full width exposed. Gold ranged from 22dwts. to 7dwts., average 13dwts. 14grs., and copper ranged from $10\frac{1}{4}$ per cent. to nil, average $5\frac{1}{2}$ per cent.

The Chief Inspector of Mines (Mr. W. H. Matthews), in 1900, took six samples close to the 330ft. level over an average width of $6\frac{1}{2}$ft., the average value being gold 12dwts. 12grs. and copper $5\frac{1}{2}$ per cent.

The arithmetical mean of the whole 23 samples is 9dwts. 16 grs. and 4 per cent. copper.

Three Hundred and Sixty Feet Level.—The Chief Inspector, in 1908, records a sample over 6ft. in width at 145ft. S. of the shaft which yielded 8dwts. of gold and 3·8 per cent. copper. Review No. 10 (1909) states that the 360ft. level is 200ft. in length.

Four Hundred and Twenty Feet Level.—There is no official record of samples from this horizon, but Mr. Lowe informed the writer that the level, which is 230ft. long (Review No. 10), was driven in white pyritic quartz worth less than a pennyweight per ton. He believes that the level was on Baker's lode, and that the lode in which values occur is still to the E. This is probable enough, as the shaft at both the 360ft. and 420ft. levels appears to be to the W. of the lode channel. Furthermore, the values recorded at 330ft. and 360ft. are in the unoxidised zone, and so complete a dying out of values in a vertical depth of 60ft. is improbable if the lode were the same.

As seen by the writer, Baker's and Masterman's (or Lowe's) lodes appear to unite some distance N.E. of the shaft. S.W. from this point a "horse" separates them, but they again come together to the S.W.

Mr. Lowe's contention, however, is that they do not unite although they may be contiguous, and that Baker's lode is comparatively barren, and was possibly filled at a slightly earlier or later period than Masterman's. Support is lent to the theory by the relationship of the cross lode system to Baker's lode. Mr. Lowe maintains that the bulk of the gold is contained in Masterman's lode. With this exception of the stoping done on the deflected portion of Cullingworth's lode W. of Baker's lode, the operations of the tributers have been wholly confined to Masterman's lode, including that portion N. of the junction of the two lodes. Even where the two lodes are contiguous the W. portion is now left unbroken.

A further feature recognised by Mr. Lowe, and of which the full significance appears to have been missed in the earlier working of the mine is the occurrence of strike faults. They do not appear to have any considerable throw, and dip as a general rule a little more steeply than the lodes, and may be marked by filling of kaolinised material up to several feet in thickness. Well-defined slickensides are to be seen on the walls of the faults in many places. These faults, cutting the lode at very acute angles, give the impression that the lode gradually tapers out, and the tendency is for a drive to follow the fault plane. This happened in the old 180ft. level N.E. drive, but later development work E. of this fault proved the lode to live for a further 100ft., at which point the level runs off into the hanging wall on a similar fault. It is probable that crosscutting to the E. at this point would again pick the lode up, as Wooton's shaft to the N.E. bottomed on lode material at 240ft., and the lode is still traceable on the surface beyond the point in question.

In the S.W. end of the Mine both the 180ft. and the 240ft. levels got so far to the W. as to pass from Critchley's through Masterman's and Baker's lodes into country. Twenty feet above the S.W. face of the 180ft. level Masterman's lode has been proved to be contiguous with Baker's and 4ft. wide. From this point Masterman's lode has been stoped by the tributors up to the 120ft. level, S.W. drive. This level has also been advanced by them and shows 4½ft. of stone in the face, also contiguous to Baker's lode. A face sample from here yielded 4½dwts. of gold per ton and 0·5 per cent. of copper.

In the 240ft. S.W. adit level a crosscut 430ft. S.W. of Masterman's shaft put out 20ft. to the S.E. proved Baker's lode to be of large size, but did not reach Masterman's lode. From this point to the mouth of the adit Baker's lode lies to the E., the adit having been driven S.W. for some distance, either on a parallel stringer or just touching the lode before turning to reach the surface. On ascending the hill above the mouth of this adit the cap of Baker's lode is seen to be so far to the E. as to render it still more improbable that the adit followed the lode closely. Still higher up the hill and at a horizontal distance of approximately 80ft. is an outcrop

that may reasonably be assumed to be Masterman's lode. A sample taken from a small pit at this point assayed 3dwts. of gold per ton and 0·1 per cent. copper. These outcrops point to Masterman's and Baker's lodes diverging at some point S. of where they are last seen together at the 120ft., 180ft., and 240ft. levels.

Baker's lode outcrop can be traced almost continuously as far as the main shaft, and stones, presumably from Masterman's, may be seen at intervals in the soil to the E. of this line.

These lodes are exposed in a cutting 45ft. and 57ft. E. of the main shaft. When sampled at these points Baker's lode yielded no gold, but Masterman's returned 10½dwts. per ton over a width of 2ft. From this point an outcrop is traceable beyond Wooton's shaft.

Lode material has been proved to be present in the faces both N.E. and S.W. of the old workings, and from the evidence afforded by the workings on the 240ft. level N.E. of Wooton's shaft and the overlying outcrops it is plain that there is still a considerable amount of ground to be explored in the oxidised zone.

Throughout any future development the possibility of losing the lode, as has happened in the past, must be kept in mind, and apparent walls should be pierced by short crosscuts or sample holes drilled at frequent intervals. Only a very small amount of work has had to be done so far to recover the lode wherever it had been lost.

The Present Appearance of the Mine.

Very extensive stopes, from 5ft. to 40ft. in width, have been taken out between the 120ft. and 240ft. levels, and have been left unfilled. The hanging-wall is supported by pillars of unworked lode and by occasional stulls. In some places the two lodes have been stoped together, in others separately.

240*ft. Level.*—Stoping has been carried on above this level to a mean distance of 170ft. N.E. of the main shaft. Beyond this point the block of ground between the 240ft. and 180ft. levels has been left untouched, with the exception of a small underhand stope 230ft. N.E. of the shaft and below the 180ft. level. Samples from the faces in this stope over widths of 7ft. and 5½ft. yielded 3dwts. and 2½dwts. per ton of gold and 0·9 per cent. and 0·6 per cent. of copper.

On the 240ft. level a sample taken from a small rise 280ft. N.E. of the shaft, over a width of 4ft. and consisting of quartz, pyrite, chalcopyrite, a little malachite, and some specular iron ore, yielded 7dwts. of gold and 3 per cent. copper. Farther on the drive was blocked, but a sample taken from the dump of Wooton's shaft, and containing the same minerals, yielded 27dwts. of gold per ton and 1·9 per cent. of copper. The position of this material on the dump leaves little doubt that it was hoisted from the shaft, and it probably came either from the sink of the shaft, where it cut the lode, or from the 240ft. drive in its vicinity, probably from the former place.

To the S.W. of the main shaft the lode is stoped for about 240ft., but most of the work has been on Baker's lode, and the lode in the S. stopes has not been completely removed. From this point the level crosses into the country W. of Baker's lode, which is seen still further on, and beyond the junction of Anstey's lode, in a short crosscut. Masterman's lode lies still farther to the E., and has not been touched at any point more than 230ft. distant from the shaft. It might well be searched for by the extension of the E. crosscut 430ft. from the shaft and at a point still nearer the mouth of the adit.

A crosscut has been put out to the E. from a point near the shaft in search of a large body of stone exposed on the hill, but has only been driven about half the necessary distance.

180*ft. Level.*—The tributers have removed a considerable stretch of ore above the N. drive to an average height of 25ft. A good deal of ore is left overhead to the N.E., and as pillars above and below the 180ft. level. A sample taken at 135ft.

N.E. of the shaft and 25ft. above the level, over 4ft. yielded 3½dwts. of gold per ton and 0·1 per cent. of copper. Another from the back of the 180ft. level at 100ft. N.E. of the shaft yielded 6dwts. of gold and 0·5 per cent. copper. From these new stopes to the new work to the S.W. the greater bulk of the lodes has been removed. At the S.W. end of the stopes the tributers have stoped on Masterman's lode, between the 120ft. and 180ft. levels, immediately below Baker's lode.

The Chief Inspector and the Inspector of Mines in 1908 (Review No. 9) and 1911 (Review No. 14) took 12 samples from various points above and just below the 180ft. level. The true mean of these samples, taking both widths and values into account, is 10dwts. over a mean width of 15ft.

120*ft. Level.*—This level has been extended some little distance to the S., and 4½ft. of stone is standing in the face. This assayed 4½dwts. of gold and 0·5 per cent. copper.

The Inspector of Mines' samples for this level showed (Review No. 14) 6dwts. for the S.W. drive and for the top of the rise.

A sample taken by the writer at 100ft. N.E. of shaft and 100ft. in depth showed 1½dwts. of gold and 0·6 per cent. of copper; and a second, from the drive E. of the shaft at the 60ft. level, assayed 1½dwts. of gold and 0·2 per cent. of copper.

Inclined rises have been put up by the tributers in lode material N.E. and S.W. of the main shaft to permit filling material broken at the surface to be sent down to the old stopes. This work is urgent, and will enable the pillars and blocks of ground now inaccessible to be removed in safety.

Broadly speaking, it may be reckoned that any ore already removed above the 120ft. level has its equivalent in the pillars that will be removed as the filling of the mine progresses. This filling is essential for the proper working of the mine, and should be done at a reasonable cost per cubic yard.

The 10 assays of oxidised ground, taken by the writer from widely separated localities on Masterman's lode, average 4dwts. of gold. The Inspector of Mines in 1912 (Review No. 17) gives an average of nine samples as 4dwts. 8grs.

When, however, the other samples of the oxidised ground are taken into consideration the average is considerably better and more in accord with the results obtained by the tributers in their crushings.

According to figures supplied by them they have crushed up to September 23rd, 1913, 3,557·75 tons for £3,106 15s., an average of 17s. 5d. per ton.*

As far as it is possible to segregate the yields they came from the following localities :—

1. Two hundred and sixty decimal seventy-five tons for £452 6s. 8d., or £1 14s. 8d. per ton from stripping the 180ft. level N.E. drive.

2. Two hundred and sixty-four tons for £416 11s. 4d., or £1 11s. 6d. per ton, from stopes above the 180ft. level N.E. drive.

3. Three hundred and thirty-five tons for £276, an average of 16s. 6d. per ton, mostly from stone won from Masterman's lode, immediately below the 180ft. level and N.E. of the Montefiore crosscut, but some probably from the stone broken from Cullingworth's lode near the same locality; 145 tons of this amount is definitely from Masterman's, below the 180ft. level, and yielded 49ozs. of bullion, on which £3 per ounce was advanced by the bank. A sample taken from a truck of ore yielded on assay 3½dwts. of gold and ·4 per cent. copper.

4. The balance, amounting to 2,698 tons, came from various portions of the mine such as the extension of the 120ft. level S.W. drive; the stopes beneath this extension and above the 180ft. level; the rises N. and S. above the 120ft. and 60ft. level to the surface; and, probably, also in part from Cullingworth's and the N.E. underhand stope below the 180ft. level.

* Mr. H. C. Mengersen, the representative at Palmer of the Port Lincoln Copper Co. supplies the following figures :—3,429 tons for £3,292·44, an average of 19s. 2d. per ton.

The writer was informed that all stone broken during the development work of rising and driving was put through the mill, and that a proportion of waste rock was included. The yield from the 2,698 tons was £1,961 17s., or 14s. 6d. per ton.

The distribution of values, as roughly indicated by these crushings, shows a shoot of fairly rich ore in the N.E. portion of the mine, and that the general tenor of the rest of the mine is above the payable grade—considering the extreme simplicity of the treatment by which it was won. The rich shoot does not appear to have been depleted, but is difficult to get at owing to the lack of filling of the stopes.

The Character of the Ore.

The upper portion of the lode, above the 240ft. level, is oxidised; below that horizon the ore changes and contains sulphides of both iron and copper.

The oxidised ore is essentially a cellular quartz gangue, with occasional vughs in which crystalline quartz occurs, and is stained with limonite and green carbonate of copper (malachite) from the decomposition of the sulphides. Copper oxide is also present. The copper is not present in commercial quantities throughout the oxidised zone, but occasionally bunches of malachite and red oxide are found, and are of good grade. Native copper is recorded by Mr. Brown. The gold occurs in a state of very fine division. Specular or micaceous hæmatite is present in considerable quantity as an original constituent of the ore.

The sulphide ore also carries a considerable quantity of specular hæmatite, and both pyrite and chalcopyrite, the former predominating. A little bornite was also recognised, and ankerite is present as a gangue mineral. The sulphides, as seen in some stone on the surface, occurs in small aggregates, and is not disseminated through the stone in a fine state of division.

Treatment.

The present plant in use on the mine consists of 10 head of 1,000lbs. stamps driven by a 50 H.P. suction gas plant. Amalgamation is used to recover the gold values, and there are no facilities for making a heavy black sand concentrate. A sample of the tailings from the last crushings, which yielded approximately £1 per ton by amalgamation, assayed 2dwts. per ton. An amalgamation test on these tailings after crushing to pass a 60-mesh screen, yielded additional amalgamable gold at the rate of 14grs. per ton.

The presence of copper in the ore, both oxidised and sulphide, debars the use of the cyanide process for the extraction of the gold, while the exceedingly fine state of division in which the gold occurs, and the presence of so much specular iron in the ore, renders the gold recovery by amalgamation only lower than is desirable. The problem of recovering further values from the oxide ores would appear to resolve itself either into a matter of finer crushing or of concentration to a black sand. Experimental work checked by assaying would be necessary to determine this point.

The installation of a concentrating table would determine whether the recovery to be made, above the present process, would outweigh the cost of concentrating and the freight and treatment charges on the concentrates produced, and be a guide for the installation of further plant if successful.

Sulphide Ore.—The Chief Inspector of Mines, reporting in 1900 on the mine, gives a brief description of the plant, which then consisted of a rock-breaker, 10 stamps, Wilfley table, Warren vanner, and a May jig. The concentrates were apparently calcined and smelted. He states that for the six months ending February 8th, 2,000 tons were treated for a yield of £2 12s. 3d. per ton, of which the last 400 tons yielded 89 tons of concentrates (22 per cent. of the ore), of a gross value of £745 3s. 4d. Samples of slimes and tailings yielded 18dwts. and 10dwts. of gold per ton and $2\frac{3}{4}$ per cent. and $1\frac{1}{3}$ per cent. copper respectively, " showing

that a close extraction under the present mode of treatment is very difficult to obtain." It is probable that these particular samples are above the average value of the tailings produced.

No estimate of the quantity of concentrates likely to be obtained can be formed at the present time. The writer estimated two heaps of sulphide ore seen at the mouth of the 240ft. adit and at Anstey's lode (W. of Reedy Creek) as likely to yield about 20 per cent.

Equal quantities of two samples of pyritic ore from the north drive on the 240ft. level, and from the dump of Wooton's shaft, were mixed and panned by Mr. W. S. Chapman, of the School of Mines, for the writer. This mixture, which consisted of quartz, specular iron ore, pyrite, chalcopyrite, and a little malachite, had a mean assay value of 17dwts. of gold per ton and 2·45 per cent. of copper. On panning it yielded—

Concentrates	11·1 per cent.
Tailings	87·5 "
Slime and moisture	1·4 "
	100 "

Assay of concentrates—

Copper	10·8 per cent.
Iron	30·6 "
Silica	17·2 "
Gold	4ozs. 12dwts.per ton, including free gold.

Assay of tailings—

Gold	7dwts.
Copper	1·4 per cent.

This is equivalent to an extraction of 59·3 per cent. of the total gold in the ore, including any that is amenable to amalgamation, and 49 per cent. of the copper content. While the sample is admittedly not wholly unoxidised, and panning is not so efficient as concentrating machinery, the result of the test confirms the conclusion arrived at by Mr. Matthews.

With these results in mind, and considering the comparatively coarse nature of the sulphides and their probable quantity and the fineness of the gold, the writer would suggest that experimental work on the sulphide ore might advisedly be done on the lines of coarse crushing and jigging to remove the bulk of the concentrates, and to obviate the loss of copper, followed by fine grinding of the jig tailings and their treatment by fine concentrators or a flotation process, the choice depending on the outcome of the experimental work. Whatever method of concentration be adopted, the concentrates would consist essentially of pyrite and specular iron ore, with the values as gold and chalcopyrite, and should be readily saleable to any copper smelter.

The large percentage of concentrates likely to be produced, as indicated by the results given by Mr. Matthews, suggest that, if the mine is worked on any considerable scale, it may be advisable to smelt the concentrates to an auriferous matte rather than pay freight and treatment charges on a large tonnage. This, however, is a question that may be deferred until the mine is producing concentrates.

Conclusion.

To sum up, the present condition of the mine in the oxidised zone is that there is a fair amount of ore to be recovered within the limits of the old stopes between the 240ft. and 120ft. levels as filling is carried out; that above the 120ft. level Masterman's lode is not depleted to any extent; that exploratory work has shown the ore to extend beyond the present faces; and that there is still a good deal of the plane of the lode to be explored beyond the present workings.

The large reef on the hill, 290ft. S.E. of Masterman's lode also has possibilities. Only very little work has been done upon it, and from Mr. H. Y. L. Brown's report in 1899 (p. 1) it appears as if 28 tons have been crushed from it for a yield of 3ozs. 10dwts. of gold, or 2dwts. 12grs. per ton.

A crosscut driven towards this lode at an early date on the 240ft. level stopped at a little over 150ft. from its starting point and proved nothing, not having reached the lode. The question of the extension of this crosscut might well be borne in mind in any future scheme of development. The lode it is aiming for is a large one and worthy of further examination.

Below the water level the numerous assays recorded at various times, and the records of crushing given by the Chief Inspector of Mines, all indicate that the grade is payable. The fact that the 420ft. level is in low-grade material for a length of 230ft. in no way invalidates this conclusion if, as Mr. Lowe asserts, the level has been driven on Baker's lode, and that Masterman's lode has not yet been proved at this horizon. A feature of the sulphide zone is the presence of copper in such quantity as to be a factor of considerable importance in the value of the ore.

While the lode, taken as a whole, cannot be regarded as high grade, it is of good size, and it should be possible to increase the known reserves of ore without much difficulty. A short crosscut to the E. off the extreme N. of the 180ft. level and, say, two E. crosscuts off the 240ft. S.W. level would speedily prove the extension of the lode, and be a guide for further development work in the upper levels.

There is a probability that the 420ft. level has not been driven on Masterman's lode. Below the 180ft. level N.E. drive the rich patch or shoot is not known, and if it lives no level below the 240ft. has been driven far enough N.E. to find it, especially as the shoots are believed to have a N. pitch.

All the evidence points to the desirability of unwatering the mine and proving the extension of the lode both longitudinally and in depth.

The facilities for working are good. Reedy Creek affords the necessary water supply and a considerable proportion of the lode is above the adit level and will be mined very cheaply. The ground stands exceptionally well and little timber will be required beyond that necessary to secure the levels and construct ore passes through the filled stopes. Mine timber is obtained from the Mount Lofty Ranges to the W. Firewood is expensive, but the experience gained with the suction gas plant using charcoal shows that power can be generated at a moderate cost.

The cross lodes, namely, Hagen's, Anstey's, and Cullingworth's, have all yielded ore not dissimilar in character to that of the main workings.

The Cottage lode, on the other hand, yielded a non-cupriferous gold ore, and stopes may be seen from the surface having a width of approximately 4ft. These lodes, and that 290ft. S.E. of Masterman's, may yet afford further supplies of ore, but attention should first be concentrated upon Masterman's lode.

With efficient management and suitable plant, and a proper appreciation of the occurrence of the ore, there appears to be no reason why the mine should not become an important and remunerative property.

Appendix—Previous Records of the Department of Mines.

"Report of the Government Geologist (H. Y. L. Brown); also Report of the Inspector of Mines (W. H. Matthews) on Kitticoola Mine," 1903.

"Record of Mines of South Australia."

"Reviews of Mining Operations in the State of South Australia." Nos. 8, 9, 13, 14, 15, 16, 17, 18.

Ochre Mine, Oodlawirra.

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REPORTS

BY

The Inspector of Mines (Mr. Henry Jones).

LOCALITY—MOUNT LOFTY RANGES.

THE PRINCE ALBERT MINE.—Situated 14 miles N.E. from Adelaide.

The property is held under three claims, Nos. 9346, 9347, 9348, on section No. 332 hundred of Onkaparinga.

A great amount of good prospecting work to shallow depths has been done at different points on the claims, and in the various workings fairly defined copper-bearing formations are exposed consisting mainly of ferruginous quartz impregnated with seams and bunches of malachite, azurite, and copper pyrites.

The workings on block No. 9346 are situated a short distance up on the W. side of a hill rising about 300ft. above the gully for a length of about 3 chains. Several open pits have been sunk to depths of from 4ft. to 10ft. In all the pits a well-defined lode formation is exposed trending N. and S. and dipping E. at an angle of 40°. The lode, 2ft. wide, consists chiefly of quartz containing copper carbonates and copper pyrites. Four samples were taken from different parts of these workings and gave, on assay—No. 1, 2·1 per cent. copper ; No. 2, from 8ft. deep, 5·6 per cent. ; No. 3, for a width of 2ft., 0·7 per cent. ; No. 4, for a width of 2ft., 1·1 per cent. A short distance down the hill from the open workings a tunnel has been extended E. into the hill for a distance of 20ft., but it does not appear to be quite far enough E. to intersect the main lode, and should be carried in further so as to prove the width and value of the ore body at a greater depth.

About a quarter of a mile S.W. from last workings, across the gully on another hill, a fair amount of work has been done in a parallel formation traversing block No. 9347 in a N. and S. direction, dipping to the W. at an angle of about 30°. The main workings on this lode are situated on the side of the hill 300ft. above the gully. An underlie shaft has been sunk in the formation to a depth of 20ft., and stoping has been carried in S. from the shaft a distance of 18ft. The ore body disclosed in the workings is well-defined, and consists chiefly of ferruginous quartz impregnated with malachite, azurite, and copper pyrites, with a small vein 6in. wide of fairly rich ore near the hanging wall. The lode down to the present level is strong and appears likely to continue in depth, and, as shown by the samples taken of the ore from different parts of the workings, it contains a fair percentage of copper :—No. 1 sample, taken from the vein 6in. wide in the S. end, gave 17·6 per cent. copper ; No. 2, for 2ft. wide, 6·2 per cent. ; No. 3, for 2ft. wide 10ft. S. from shaft, 3·6 per cent. ; No. 4, from vein 6in. wide N. end, 16·6 per cent. ; No. 5, taken from ore dump on surface, 10·3 per cent.

At the foot of the hill open-cut workings have been made for a length of 10ft. by 3ft. deep, in which are exposed strong quartz lodes with copper stains and iron pyrites 3ft. wide bearing N. and S. and dipping E. at an angle of 45°. A sample taken of the lode material from different parts of the cutting gave 0·4 per cent. copper.

At a few chains further up the gully from the last workings a large amount of mining work appears to have been carried on some years ago. One vertical shaft was sunk to a depth of 70ft., and has recently been cleaned out and secured down to 60ft. level, and the drive E. at that depth been cleaned out for a distance of 65ft. In the end of the drive a winze has been sunk in the lode but is now full of mullock, and could not be examined. The formation disclosed in the

drive strikes E. and W., with slight angle to the S., and consists of quartz, gossan, and decomposed shale varying from 12in. to 3ft. wide. Four samples taken of the lode material from different points in the drive and from the face gave no value.

About 1½ chains N. from the vertical shaft a tunnel was started in the outcrop of an E. and W. lode dipping S. The tunnel has been extended E. in the formation, a total distance of 65ft. The lode material disclosed in the drive is chiefly quartz and quartz crystals, 12in. to 24in. wide, stained with copper carbonates. A sample taken of the lode from half way in the drive gave 0·8 per cent. copper.

So far all the different lodes exposed in the present limited workings are of a promising nature, and the prospects of the N. and S. bearing formations for containing rich shoots of ore are very encouraging. There are also strong indications at different points on surface of other lodes traversing the blocks that fully justify further systematic prospecting being done to locate them, and also to prove the present lodes to a greater depth and more extensively along the line of strike. (15–7–13.)

Hermann's Mineral Claims.—Situated N. of and adjoining the N. boundary of the Prince Albert Mine, 14 miles N.E. from Adelaide, section No. 331, hundred of Onkaparinga.

A large amount of mining work has in times past been done on different parts of the property by open cuts and shallow pits ; and in the various workings a number of parallel lode formations are disclosed, varying in width from 2ft. to 3ft., containing copper ore.

On the E. side of the gully, 100ft. up the side of the hill, a tunnel has been driven E. in a lode formation for a distance of 27ft. The lode consists of ferruginous quartz, 12in. to 18in. wide, carrying copper ore. A sample taken from the face of the drive gave 1·3 per cent. copper, and a sample taken from a parcel of ore at surface, obtained in driving, gave 3·9 per cent. copper.

About 200ft. up the hill an underlie shaft has been sunk to a depth of 35ft. in lode formation bearing N. and S., dipping E. at an angle of 45°. Stoping has been carried in S. from the shaft for a distance of 6ft. ; the lode is well-defined and consists of ferruginous quartz, 3ft. wide, stained with copper carbonates. A sample taken from the face of the S. stope for a width of 3ft. gave 0·3 per cent. copper.

Three chains S. from last workings an underlie shaft has been sunk to a depth of 15ft. in a parallel formation bearing N. and S. dipping E. The matrix of the lode is shale and quartz, 3ft. wide. A sample taken from the bottom of the shaft gave 1·9 per cent. copper.

About 30ft. E. and 2 chains further S. a hole has been made to a depth of 8ft. in a fairly defined formation of quartz and shale, 2ft. wide, carrying carbonate ore, chiefly malachite. A sample taken from the bottom gave 2·3 per cent. copper.

Near the top of the W. hill, about 400ft. above the gully, a fair amount of open-cut work has been done in an E. and W. lode dipping S., and one underlie shaft sunk in the formation to a depth of 15ft. The ore-bearing material disclosed consists chiefly of quartz, 3ft. wide, impregnated with carbonates. A sample taken from the bottom of the shaft gave 2·1 per cent. copper, and a sample taken from the N. end of cutting gave 1·4 per cent. copper.

On top of the hill a pit has been sunk to a depth of 13ft. in a lode formation, bearing N. and S. dip E. The lode exposed consists of quartz, 2ft. wide, stained with carbonates. Eight chains further N., at the end of Joker's Gully, open-cut workings have been made to a depth of 10ft. in a formation bearing E. and W. dip S. The lode material exposed in the cut is chiefly quartz, 2ft. wide, containing malachite and azurite. A sample taken from the bottom gave 6·0 per cent. copper. About 5 chains N. from the last workings a large quartz lode is showing in a shallow open-cut, but at that point is poor. A sample taken gave no value. Further N., at the end of a small gully, open-cut work has been done for a length of 10ft., in which is disclosed a lode formation consisting of ferruginous

quartz, 2ft. to 3ft. wide, bearing N. and S. dip E. A sample taken from different parts of the workings gave 3·0 per cent. copper.

A considerable number of fairly defined lode formations containing copper ore are exposed in the shallow workings, both on this block and on the adjoining property. (The Prince Albert), and the indications in the present workings appear very favorable for the occurrence of large deposits of ore in places, and warrant further exploration work being done in the formations. (16–7–13.)

LOCALITY—NORTH-EAST.

The Ajax Gold Mine (now worked by the Babylonian Company), *vide* Record p. 196 and Reviews Nos. 8, 11, 14, 16, 17, and 18, situated near Waukaringa.

Mining work on a fairly large scale is now carried on at this mine, and a good number of men are employed underground and on surface.

At the 170ft. level from the main underlie shaft the N.E. drive in the lode has been extended to a total distance of 150ft. At a point 100ft. from the shaft in the drive a small break occurred in the ore channel, displacing the lode a distance of about 2ft. to the E. The lode continued in for 30ft. when a second fault occurred shifting the ore body back to its usual course. A large portion of the drive has been strongly timbered preparatory to stoping, and an air shaft has been started from the surface and sunk to a depth of 48ft. When the shaft and drive are connected this section of the mine will be adequately ventilated, and a large block of new ground will be available for stoping.

The drive S.W. in the lode is in a total distance of 210ft. from the main shaft, and has been connected with No. 2 shaft. Stoping is in progress each way from No. 2 shaft, and the ore from the workings is conveyed to the level through a strongly constructed ore pass, and is hauled up No. 1 shaft and tipped into the battery ore bin. At the 140ft. and 130ft. levels in No. 3 underlie shaft stoping is in progress also ; the ore body in the working is well-defined, varying in width from 12in. to 15in.

No. 5 underlie shaft has recently been cleaned out to a depth of 30ft. and a horse-whip erected for hauling purposes; and ore is being stoped both N.E. and S.W. from the shaft in an ore body 15in. to 20in. wide.

In a shallow open-cut workings further S.W. work is carried down in the lode and a very promising shoot of ore is exposed in the bottom averaging 24in. thick and dipping N.E. in the direction of No. 5 shaft, and as the S.W. workings from the latter are extended the same shoot of ore will doubtless be intersected.

About 200 tons of ore per month are extracted and treated from the various workings yielding from 10dwts. to 12dwts. of gold per ton. The ore body throughout the mine is persistent, and the prospects of this mining venture appear very promising.

The treatment plant on the mine consists of a 10-head stamper mill and agitating cyanide plant driven by suction gas engine with belt and clutch gear adjusted so that the two plants can be worked simultaneously or singly as required.

Ample water supply for crushing and other purposes is now obtained from the new well. It is pumped a distance of 3½ miles to the mine by an oil engine through 3in. piping. (13–6–13.)

Further Report.

In the main underlie shaft at the 70ft. level driving on the course of the lode is in progress. The N.E. drive is in a total distance of 26ft. ; the lode formation disclosed varies in thickness from 1ft. to 3ft., and as the drive is extended E. a large block of ground will be made available for stoping. The drive S.W. opposite the last is in a total distance of 55ft. ; the formation is from 18in. to 2ft. wide and appears very promising. When the present drive has been connected with No. 2 shaft, and the rise that has been started from 120ft. level is through to the

drive, the large block of ground below the 70ft. drive can be very conveniently stoped out and the necessary mullock conveyed down the new pass for filling in the stopes.

Stoping and rising are in progress from the 120ft. level E. of No. 2 shaft. A new make of ore on the footwall close to the main body and parallel with the latter was discovered in these workings recently. The vein shows nice gold for a width of 3in., and should it prove permanent and extend to other parts of the mine it will greatly facilitate mining operations and considerably increase the tonnage of ore from the holding.

In No. 3 shaft at 130ft. level the work of extending the S.W. drive is in progress, total distance now being 230ft. from the shaft. The lode formation showing is well-defined, averaging fully 18in. wide. As this drive is extended W. a large block of new ground will be made available for stoping.

The crushing and cyaniding plant on the mine is doing good work, and everything appears in splendid order for carrying on. (10–10–13.)

The Blackfellow's Reef Gold Mine (*vide* Record p. 209).—Situated 7½ miles from Waukaringa.

Some years ago a large amount of prospecting was done on this property by open-cut work and shaft sinking, and it is said that a fair quantity of coarse gold was obtained from the various workings.

There are several small reefs enclosed in the hard argillaceous sandstone traversing the block bearing N.E. and S.W., with an angle of 45° to the N.W.. Two shafts on the underlie were sunk in separate seams of ore to depths of 20ft. and 45ft. respectively. The veins of ore disclosed in these old workings are well-defined, but small, varying in width from 3in. to 6in. of quartz, iron pyrites, and iron oxide. Two samples taken from the vein in the bottom of the 45ft. shaft gave no values on assay, and one sample taken from the vein in the 20ft. shaft was also nil : this shows that the ore at this point on the block is of no value. The country in this district is highly auriferous, and it appears quite possible that veins of larger size and better value may be found at the above reefs and also at others in other parts of the property. (13–6–13.)

Langsford Mineral Claim.—Situated at Lovely Gully (*vide* Record p. 211 and Review No. 17.)

A new vertical shaft was recently started on the property on the W. side of the N. and S. lode with a view to intersecting the latter at a reasonable depth. The shaft is now down 23ft. from the surface, and at a depth of 20ft. a small seam of ferruginous material 15in. thick crossed the shaft. A sample taken from the vein gave 0·1 per cent. copper and gold nil.

In the old Laura underlie shaft, 160ft. level, a fair amount of prospecting work has recently been done in the footwall country. A vertical pit has been sunk to a depth of 12ft. Several thin veins of quartz and pyrites were passed through. A sample taken from the veins and assayed gave no values. A sample taken of the Laura lode, 8in. wide at the 60ft. level, gave 6·1 per cent. copper and a trace of gold.

Four chains E. from the underlie shaft six prospecting pits, 5ft. to 7ft. deep, have been sunk recently in the alluvial deposit. In four of the holes nothing of value was discovered, but in No. 5 and 6 holes a thin stratum of sand and clay containing fair gold is showing overlying the rock. Several samples were taken and washed from No. 6 hole ; in all of them a number of specks of coarse and fine gold were showing. (14–6–13.)

The Kirkeek's Treasure Gold Mine (*vide* Record p. 225 and Reviews Nos. 8, 11, 13, 15, 16, 17, and 18).—Situated on the Nillinghoo Goldfield.

A large amount of work is at present in progress on this mine preparatory to resuming further sinking of water shaft now down to a depth of 340ft. from surface. The boiler has been cleaned out, the plant and pump have been overhauled, and the necessary repairs made, and everything is now in splendid working order.

Two water storage tanks, 400galls. and 2,500galls. respectively, have been placed on the brace near the shaft, and two new $\frac{5}{8}$in. flexible steel wire ropes have been placed on the winding drums, with two new 35galls. kibbles made of mild steel for sinking.

The upper portion of the shaft from the surface 44ft. down has been made larger and all the old timber taken out. This has now been closely and strongly timbered with jarrah 6ft. 6in. by 2ft. 11in. in the clear, and the other portions of the shaft overhauled and made secure.

The accumulated water in the shaft amounting to about 17,000galls. has been bailed out, and the work of cleaning out is now in progress.

At the mine a start has been made to drive S. across the formation at the 35ft. level; the ore is chiefly quartz and iron. Three samples taken from different parts :—

No. 1 gave 1oz. 2dwts. of gold per ton.
No. 2 " 2ozs. 1dwt. "
No. 3 " 1oz. 5dwts. " (16–6–13.)

The Great Lionel Gold Mine.—Situated at Teetulpa Goldfield, 25 miles N.W. from Mannahill.

There are two sets of parallel reefs traversing the property. The N. and S. reefs have been extensively prospected at different points by shaft sinking for a length of from 3 to 4 chains, but so far comparatively little work has been done in the cross leaders (or E. and W. series of reefs). The lode matrix consists mainly of ferruginous quartz, gossan, brown iron ore, iron pyrites, and bismuth.

Near the W. boundary of the blocks in Lionel's reef at different points three shafts are down to 20ft., 30ft., and 75ft. respectively, and about 5 chains further S. No. 4 shaft is down to a depth of 50ft. The reef formation showing in the various shaft workings near the surface is chiefly ferruginous quartz and iron containing a little bismuth and a trace of gold, and varying in width from 2ft. to 3ft.

There are two reefs E. of Lionel's about 150ft. apart. In the E. one, two shafts are down to depths of 25ft. and 60ft. respectively. The lode material showing in the shafts and along the surface is ferruginous quartz and iron, 12in. to 20in. wide.

Several chains further N. a pit has been put down in Lionel's reef to a depth of 7ft. The reef exposed is well-defined and from 12in. to 18in. wide of quartz and iron seams carrying a trace of gold.

Some prospecting work has been done on other parts of the holding in *Smith*, *Little Jim* and *Perry's* reefs. The lode material disclosed is from 8in. to 12in. wide of quartz and iron veins and iron pyrites, carrying gold, as showing by nine samples taken, which gave, on assay, from a trace of gold and bismuth to 6dwts. gold and trace of bismuth.

All the old workings mentioned were done many years ago, and it is quite possible that some good ore was obtained from the reefs while work was in progress, as all the dumps sampled show traces of gold. The various reefs exposed on the blocks are well-defined, varying in width from 6in. to 36in., with strong indications of them extending along the lines of strike and continuing to depth, and they probably will contain rich shoots of ore at points where the E. and W. veins intersect the main reefs. (11–10–13.)

The Homeward Bound Gold Mine (*vide* Record p. 245, and Reviews Nos. 9, 11, 14, 15, and 18).—Situated near Mannahill.

Since my last visit a fair amount of stoping work has been done in the lode N. and S. from the bottom of the 30ft. underlie shaft, and about 30 tons of ore, averaging 1oz. 15dwts. of gold per ton, were extracted from the workings.

A new vertical shaft was recently started at a point 60ft. S. from the underlie, and sinking has now reached 20ft. It should intersect the lode within the next 10ft., and it is anticipated that the rich shoot of ore operated on in the underlie shaft will continue S. to the new workings.

Five chains E. from last workings a fair amount of work has recently been done from the outcrop of the lode to a depth of 25ft., and 4 tons of ore obtained from the pit and workings gave 2ozs. 5dwts. of gold per ton.

About ¼ mile S. from the above workings the outcrop of a well-defined lode is exposed, showing a width of 16in. and a strike parallel with Homeward Bound lode. Three samples taken from the outcrop gave—

No. 1, trace of gold and 2ozs. silver per ton.
No. 2, trace of gold and 5ozs. 16dwts. silver per ton.
No. 3, 2dwts. of gold.

There was a little bismuth in each sample. (12–10–13.)

The New Milo Gold Mine (*vide* Record, p. 322, and Reviews 10, 11, 14, 15, and 18).—Situated at Wadnaminga Goldfield.

At the 370ft. level in the main underlie shaft the W. drive on the course of the lode is in a total distance of 215ft. Off the drive near the face stoping is in progress. The ore body exposed in the workings is from 1ft. 6in. to 2ft. 6in. wide, and consists of ferruginous quartz, iron pyrites, and ironstone veins carrying gold. A sample taken from the face of the drive for a width of 18in. gave 14dwts. of gold per ton by assay, and one from stope for a width of 24in. 2ozs. 1dwt. gold per ton. There are about 23 tons of ore from above workings on surface to be carted to the Virginia battery for treatment.

Near the E. end of the holding a fair amount of work has recently been done. One shaft on the underlie of the lode sunk to a depth of 35ft., is now connected with a vertical shaft sunk to a depth of 23ft. In the bottom of both shafts the lode is chiefly ferruginous quartz, 18in. wide, between two well-defined walls. In the present workings the lode does not appear to be carrying much gold, as a sample taken for full width only assayed 1 dwt. of gold per ton. It looks a promising ore body, and when more developed may prove to contain more gold. (13–10–13.)

The Virginia Gold Mine (*vide* Record, p. 323, and Reviews Nos. 14, 15, 16, 17, and 18).—Situated at Wadnaminga.

The principal work recently carried on consists of the erection of a cyanide plant to treat the large quantity of tailings that had accumulated on the property, as well as those to be made in future by continuous crushing of ore from the mine, and also those obtained from other properties in the vicinity. The plant consists of four precipitating vats, two settling vats, and two solution vats, pumps, and all necessary connections have been made and placed in position. An assay plant and gold smelting furnace have been installed and housed in, and everything is now in very good working order, and two large parcels of sands have already been treated.

The first parcel, amounting to 192 tons, gave a return of 36ozs. 4dwts. bar gold, equal to 90 per cent. extraction, and the second of 230 tons of lower grade material gave a return of 35ozs. 5dwts. bar gold. There are about 5,000 tons of sands in the dump to be yet treated. At a point on the property near the vertical shaft there is a vein of ore outcropping which by its trend should junction with the main lode. A sample taken for a width of 3in. at outcrop gave 2ozs. 1dwt. of gold per ton.

A sample from No. 1 mullock dump with ore through it gave ½dwt. of gold. One from No. 2 gave 8dwts., and one from No. 3, 3dwts. of gold per ton.—(14-10-13.)

New Medora and Mount Grainger Gold Mine (*vide* Record, p. 250, and Reviews Nos. 8, 9, 13, 14, 15, 16, 17, and 18, and Geological Report No. 2.—Situated about eight miles from Oodla Wirra Railway Station.

In the main shaft at the 90ft. level stoping is in progress. A large formation 20ft. wide is exposed in the workings, consisting of decomposed slates, talcose schist, quartz and iron seams carrying gold. Three samples were taken from a ferruginous vein (12in.) traversing the centre of the formation, and gave on assay :—No. 1, from near the footwall for a width of 12in., 3·5dwts. gold per ton ; No. 2, centre of lode 10in. wide, 18dwts. ; No. 3, face of stope, 8in. wide, 12dwts.

The formation is chiefly soft material easily worked, and should yield a large amount of ore for battery treatment.

About 35 tons of lode material have recently been hauled to the surface from the present workings and stacked on the battery floor and a start made to treat it with five head of the stamper battery on the mine, and everything appears in a good way to keep that number of stamps working for some time.—(15-10-13.)

Watkins' Claim (9657).—Situated one mile N.W. from Mount Grainger.

The workings consist of one open-cut, 20ft. long and 8ft. deep. A vein of ore is exposed for the whole length of the cutting, bearing N.E. and S.W., dip N.W., and consisting of ferruginous slate and quartz, 12in. to 15in. wide, carrying gold. The ore body appears of a permanent nature, traversing the auriferous slate belt, and is likely to contain rich ore in places.

An underlie shaft should be started near the S.W. end of the open-cut and carried down in the formation to prove the width and value of the ore at depth. A sample taken for a width of 15in. in the bottom of the hole, 8ft. from surface, gave 11dwts. ; and one taken from parcel of ore on surface gave 3dwts. of gold per ton.—(15-10-13.)

The Golden Junction Gold Mine (*vide* Record, p. 219).—Situated N. of the Mount Grainger Mine.

At the 30ft. level in the old underlie shaft, driving and stoping are in progress. The ore body disclosed in the workings consists of decomposed ferruginous slate, 6in. to 12in. wide, carrying rich shoots of gold in places down to a depth of nearly 200ft., as was amply proved while the present underlie shaft was being sunk, for although the vein of ore in the shaft was irregular and varied in width from 3in. to 12in., the ore obtained in sinking yielded sufficient gold to pay for all the work done.

There are other promising veins of ore outcropping at different points on the block and traversing the auriferous slate belt that are worth a little prospecting work being done to prove them.

A sample of ore taken from the face of the present workings at 30ft. level gave 10dwts. of gold per ton, and a sample taken from the 3 tons of ore on surface ready to send away for treatment gave 2ozs. 1dwt. of gold per ton.—(15-10-13.)

Queen Mary Gold Mine (*vide* Review No. 18).—Situated on section 97, hundred of Parnaroo, 10 miles S.E. from Oodla Wirra.

A fair amount of prospecting work has recently been done at different points along the strike of the formations at depths of from 3ft. to 4ft., and for a length of 5 chains. Lode formation is exposed in the various workings, varying in width from 18in. to 30in., and consisting of quartz veins, quartzite and manganese, with small iron seams in places crossing the formation at right angles to the bearing.

The main underlie shaft in No. 1 lode is down 30ft. ; at that depth a crosscut has recently been extended W. in the hanging wall a distance of 5ft. A small iron seam 3in. to 4in. wide, and bearing E. and W., is showing in the crosscut, and, as shown by a sample taken from the vein in the face, it contains a little gold. The sample gave 1½dwts. of gold per ton.

A sample taken from the western formation in the open-cut gave 1dwt. of gold per ton, and one sample taken from the outcrop of the eastern one, 10ft. E. from shaft, gave 1dwt. of gold per ton.

The prospects of the lode so far are discouraging, but it may possibly contain shoots of better ore at other points.—(16-10-13.)

Only-a-Dream Gold Mine (*vide* Review No. 18).—Situated in the hundred of Hardy, 18 miles E. from Ucolta Railway Station.

The main underlie shaft on the property has recently been further sunk a distance of 37ft., making the total depth 70ft. from the surface. The reef all the way down the shaft is well-defined, consisting of ferruginous quartz, 9in. to 10in. wide. From the sinking of the last portion of the shaft 5 tons of ore extracted were treated at the Petersburg Cyanide Works, and gave a return by battery of 3dwts. 14grs. of gold per ton.

The ore body in the bottom of the shaft is of a very promising nature, but at that particular point contains no gold. Two samples taken, one from each end of the shaft, and also one sample from a seam of soft material on the footwall showed no values.

Now that the shaft is down a reasonable depth, and in good order for hauling purposes, it would be a good plan to extend the drives on the course of the reef each way to prove the extent of the shoots of ore passed through in sinking, and to explore the eastern portion of the holding where probably other shoots of ore will be discovered.—(16-10-13.)

The Golden Record Gold Mine (*vide* Record, page 321, and Reviews Nos. 14, 15, and 18).—Situated at Wadnaminga.

Work is still carried on from the underlie shaft at the 70ft. level. The drive E. at the bottom is in a total distance of 10ft., and in the face a promising indicator is showing. On this field the richest patches of ore have generally been found at points where the reefs are associated with the indicators (or cross leaders), which are found to traverse both the foot and hanging wall country rocks.

In the back of the drive a rise has been started. It is intended to carry it up on the trend of the indicator, and quite possibly a rich make of ore will be discovered at no great distance up.

The reef exposed in the drive and rise is chiefly ferruginous quartz, 9in. to 12in. wide, and the ore in the face of both workings at present is poor, as shown by the three samples of lode material taken, which gave on assay only a trace of gold; but, as the gold occurrences in the reef are patchy, a little further driving may show the ore to be of much better value. (13–10–13.)

LOCALITY—NORTH.

The Robertstown-Bright Silver-Lead Mine (*vide* Reviews Nos. 17 and 18).—Situated 7 miles from Robertstown.

A considerable amount of work has recently been done, and is now in progress on this property: the necessary buildings to carry on the work have been erected, and a fair amount of preliminary prospecting has been done at different parts of the blocks.

A prospecting shaft was recently started in the main lode formation with a view to accurately determine the true dip width and value of the ore body at a reasonable depth prior to the selecting of a site for a main working shaft.

The present shaft is 6ft. by 4ft. in the clear, sunk 30ft. vertical and 130ft. on the underlie in the hanging wall portion of the lode. The width of ore left on the footwall has not yet been determined. The manager intends first to continue the shaft down to the 200ft. level, and then cut out a plat and put in crosscuts to prove the

width and value of the lode. The shaft is equipped with good strong ladders and runners, and everything appears in good order to carry down the shaft to the proposed depth.

The portion of the formation disclosed in the shaft is of a very promising nature, and consists of ferruginous quartz and dolomite, with a well-defined vein of fairly high-grade ore near the hanging wall, varying in width from 6in. to 15in. A sample taken from the vein for a width of 15in. in the N.W. end of the shaft at the 160ft. level gave 36·15 per cent. lead and 1oz. 10dwts. silver, and a sample taken from the the vein for a width of 6in. in the S.E. end of the shaft gave 23·38 per cent. lead and 12dwts. silver. At the same level a sample was taken of the hanging wall material, which gave no value at that point in the shaft.

There are several tons of ore on surface obtained in sinking the present shaft. A sample taken from the dump gave 31·10 per cent. lead and 10dwts. silver per ton.

Developments so far on this property are very encouraging, and fully justify the sinking of the present shaft a further depth of 40ft., so as to more fully prove the lode at a reasonable depth.—(4.7.13.)

The Blinman Copper Mine (*vide* Record, p. 31, Reviews Nos. 7, 14, 15, 16, and 18.—Situated 18 miles from Parachilna Railway Station.

Owing to the main shaft being in bad order since the fire which burnt out the shaft timber down to the 50-fathom level, no work has since been done below the 35-fathom level. At the latter, and at various points along the outcrop, a fair amount of work is in progress.

The lode formation disclosed is from 30ft. to 35ft. wide, striking N. and S. it appears to go down fairly vertical, and consists of crystalline limestone, quartzite, and calcareous sandstone, with specks and patches of copper ore disseminated through the rocks, and in places seams of ore 1in. to 12in. wide are running across the formation in an E. and W. direction. These veins apparently at different points open out, forming large bodies of high-grade ore.

About 100ft. S. from the main shaft an underlie working has been carried down to a depth of 20ft. The vein of copper ore exposed in the bottom is well-defined and fully 15in. wide.

During the last three years 300 tons of 17 per cent. ore have been marketed from the various workings, and at present there are 16 tons on surface ready to send away. A sample taken from a dressed parcel gave 30·8 per cent. of copper, and a sample from 20ft. pit gave 10·8 per cent.—(24-10-13.)

Paull's Consolidated Copper Mine (*vide* Record, p. 116. and Reviews Nos. 9, 13, and 17).—Situated about 26 miles from Leigh's Creek.

A large amount of good developmental work has been done at one time on this property, and several shafts have been sunk along the line of lode to various depths. The main shaft is down to 300ft., a fair amount of driving and stoping has been done at different levels, and large quantites of high-grade ore were extracted from the workings.

During the last 10 months stoping has been carried on in a block or ground between the 150ft. and 90ft. levels for a length of 30ft., and 20 tons of ore extracted from the workings averaged 22 per cent. copper.

At the 90ft. level in the main shaft driving E. in the foot-wall portion of the lode is now in progress, and it is intended to continue up to the prospecting shaft, which will make a long length of ore available for stoping. The formation in the face of the drive appears highly promising, consisting of vertical claystone with thin veins of ribbon ore distributed through it, and several seams of cuprite and malachite for a width of from 4ft. to 6ft. Samples taken from three of the seams at different points in the drive :—No. 1, from vein 8in., gave 27·8 per cent. copper ; No. 2, vein

3in., gave 32·8 per cent ; No. 3, vein 6in., centre of drive, 50·3 per cent. A sample from outcrop close to top of east shaft vein 9in., gave 7·1 per cent. copper.—(26-10-13.)

The Mount Coffin Copper Mine (*vide* Record, p. 87, and Reviews Nos. 9, 13, and 16).—Situated near Leigh's Creek.

At the 50ft. level in the underlie shaft the drive E. is in a total distance of 120ft., and is being extended. Stoping is also in progress. The lode formation showing in the face is 2ft. wide, and consists mainly of jointed slate with seams of fairly high-grade ore, 3in. to 8in. wide, chiefly cuprite and malachite, near the hanging wall. A large amount of work has been done in the lode from the bottom of the shaft up to the present level, a block of lode formation for a length of about 200ft. E. and to a height of 40ft. has been stoped out, from which large quantities of good marketable ore were obtained. All the old stope workings have been properly filled up with mullock, and everything kept in good working order.

There are 12 tons of ore bagged at the mine ready to send away for treatment. A sample taken from a small parcel of dressed ore, not bagged, gave 16·3 per cent. copper, and a sample taken from second-grade dump gave 9·2 per cent. copper.—(27-10-13.)

Diamond Jubilee Copper Mine (*vide* Record, p. 49, and Reviews Nos. 9 and 13).—Situated 9 miles E. from Leigh's Creek.

There are stong indications of several copper-bearing lodes traversing the property in an E. and W. direction, and going down vertically.

A fair amount of good prospecting work has been done in three of the lodes to depths of from 50ft. to 130ft. by shaft and tunnel workings, and a large quantity of rich copper ore has been obtained from the different formations.

The lode matrix exposed in the different workings is well defined, consisting of quartz and ferruginous calcite and argillaceous slates containing seams and bunches of cuprite, malachite, and ferruginous copper-glance.

The principal work now in progress is the cleaning out of No. 1 winze sunk from the E. drive off the tunnel. The work has been carried down to a depth of 10ft., the lode formation showing in the ends of the winze is 4ft. wide, carrying seams and bunches of nice ore, chiefly cuprite and malachite, 1in. to 3in. wide. A sample taken from the vein in the W. end of the winze gave 26·5 per cent. copper, and a sample taken of the outcrop of the lode, 3ft. wide, 5 chains E. from tunnel, gave 7·9 per cent. copper, and one sample taken of lode material, said to come from bottom of 45ft. shaft on side of th hill, gave 21·3 per cent. copper.—(27-10-13.)

The Dorris Fabian Copper Mine.—Situated about 26 miles eastward from Leigh's Creek, E. of and adjoining Paull's Mine.

A large amount of good prospecting to a shallow depth has been done at different points for a length of 60 chains along the E. and W. line of strike, and in the various pits and open workings a copper-bearing formation of a highly promising nature is exposed.

On block No. 9441 a vertical shaft has recently been sunk to a depth of 40ft., the last 15ft. of sinking was in the hanging wall portion of the formation, which contained several seams of rich ore, and at the 20ft. level a crosscut has been extended N. 20ft. The lode formation passed through is 11ft. wide, consisting of calcareous claystone and silicious ironstone, with thin veins of copper glance and carbonate of copper, ½in. to 6in. wide. The large seams of copper-bearing ore are parallel with the formation, and from 12in. to 24in. apart. Some of the veins are fairly rich in copper ore, chiefly bornite, cuprite, and malachite ; the lode at this point appears very promising and should be thoroughly tested by deeper sinking and driving. A parcel

Ochre Mine, Oodlawirra.

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Driving both ways on the course of the lode has been started, and the N.W. drive is in 4ft. The lode consists of ferruginous quartz with copper ore densely distributed in specks and bunches through the lode matrix for a width of 4ft. A bulk sample taken across the lode in the face of the drive gave 14·2 per cent. copper.

The S.E. drive has been extended a total distance of 14ft. The lode matrix is chiefly quartz, containing rich pockets and patches of malachite, bornite, and copper pyrites for a width of from 4ft. to 4ft. 6in. A bulk sample of ore taken from the face gave 9·5 per cent. copper, and a sample taken from a seam of ore 18in. wide gave 28·3 per cent. copper. The lode formation in both drives is strong, with two well-defined walls, and everything indicates that the lode is a permanent ore body and likely to extend on its course for a great distance as well as continue down.

The workings at present depth are in good solid and settled country, and I would strongly recommend continuing both drives to further prove the ore body for greater lengths prior to selecting a shaft for a main shaft. When the N.W. drive is further extended to a point under the gully, a small shaft could be put down to meet the drive and to ventilate the mine, so that the extension of the workings could be done under more favorable and safer conditions.

No. 2 shaft situated about 3 chains S.E. from No. 1, has been sunk to a depth of 100ft. At 56ft. from the surface a lode formation bearing N.E. was intersected, consisting of quartz and quartzite carrying copper ore, chiefly azurite and malachite for a width of 3ft. A sample taken of the lode material where passed through by the shaft gave on assay 3·2 per cent. copper. By the trend of this formation it should junction with the lode in No. 1 workings at a point about 2 chains S.E. from the shaft.

The development at present depth on this property is most valuable, as it fully demonstrates that by all appearance the ore body in No. 1 shaft will prove permanent and contain higher values as depth is attained.—(3-11-13.)

West Burra Copper Mine (*vide* Review No. 18).—Situated about 3½miles S.W. from the Burra Burra Mine.

The principal work in progress on the property at present is the sinking of the underlie by contract, 6ft. by 4ft. in the clear, now down a total depth of 62ft., and equipped with runners and ladders from surface to bottom.

In the shaft from the surface to a depth of 40ft. a vein of fairly rich ore is showing 4in. to 6in. wide ; at this point the country is disturbed and faulty, and it appears quite possible that the rich seam of ore has been thrown either to the foot or hanging wall, the latter most probably. From the 40ft. level the sinking appears to have been done in portion of the formation, which consists of decomposed ferruginous clayslate and quartz stained with copper carbonates, but of not much value at present depth. Two samples taken from the bottom of the shaft gave 0·5 per cent. and 0·1 per cent. copper respectively. As the ground in the shaft appears much disturbed sinking should be continued down to settled country, then crosscut into both walls. A sample of the vein of ore at 40ft. level for a width of 6in. gave 34·3 per cent. copper, and one from a small dump of ore on surface 30·4 per cent. There is every indication in the present workings of the formation continuing down, and deeper sinking to prove it in settled country is fully justified.—(4-11-13.)

The Belalie Copper Mine.—Formerly " Wheal Sarah " and " Bundaleer " (*vide* Record, p. 150, and Reviews Nos. 10, 12, and 14).—Situated on section 22, hundred of Bundaleer.

Since the present company commenced operations on this property a large amount of good development work has been accomplished.

From No. 2 tunnel at the foot of the hill a crosscut has been extended a distance of 313ft. in hard country, and is now connected at the 100ft. level with the vertical

shaft sunk from the top of the hill. At 270ft. in the crosscut a well defined lode formation, 2ft. to 3ft. wide, was intersected (called N. lode), a drive has been extended E. in the lode for a distance of 28ft., and at that point a fault occurred in the country, displacing the ore body, and judging by the trend of the fault the eastern portion of the lode has been thrown N., and probably will be found by a short crosscut put into the hanging wall from the face of the present drive.

At a point 22ft. in the E. drive a winze has been sunk to a depth of 26ft. in the N. lode ; the lode formation, both along the drive and winze is well defined, containing bunches of fairly high-grade carbonate ores in places, and varying in width from 2ft. to 2ft. 6in.. it appears a very promising formation for the distance exposed, and is well worth being further developed by continuing down the present winze to a depth of 100ft. from bottom of drive. from that level a crosscut could be put in S. to intersect the S. lode, the money required to carry out the above-mentioned work would be well spent and would prove the width and values of both the N. and S lodes at a depth of over 200ft. from the surface at a comparatively small cost.

So far no work has been done W. from the tunnel to prove the N. lode, which is fully 2ft. 6in. wide where intersected, and appears highly promising and well worth exploration westward. A drive should be started on the course of the lode from the tunnel (which is about 100ft. below the outcrop) ; the work would properly test the value of the ore body, also open out the mine, and if the ore proved payable a large extent of ground would be made available for stoping.

About 30 chains S.E. from the main workings a fair amount of good prospecting work has recently been done. One shaft, 6ft. by 4ft. in the clear, has been sunk to a depth of 38ft. The top part has been strongly and securely timbered down to the solid rock: at the bottom of the shaft a crosscut has been put in 26ft. W., at 24ft. copper-stained rock was intersected. and is still showing in the face, but it appears of little value t present. The outcrop of the same formation is showing on surface, a short distance W. from the shaft. and is about 3ft. wide, stained with blue and green carbonates, but apparently of low grade in bulk. There are other outcrops on the surface E. and N.E. from the present shaft, showing green and blue carbonates and specks of sulphide ore. The best plan at present to prospect this part of the holding would be deep trenching, and if reasonable values were found in the formations they could be tested at greater depth by shaft sinking.—(12-11-13.)

The Black Eagle Copper Mine (*vide* Reviews Nos. 10, 12, 13, 16, and 17).—Situated 1 mile S. from the Ediacara Mine.

No. 2 adit, started from the side of the hill, has been extended E. a total distance of 80ft., and from that point a drive made N. in the ore for a distance of 60ft. Off this, at a point 24ft. in, a drive N.W. for a distance of 55ft. has been made. At the extreme end of the northern workings a drive in the ore has been extended E. 24ft. The ore-bearing material disclosed in the different workings is an irregular horizontal deposit of ferruginous quartz and siliceous ironstone boulders of various sizes, intermixed with decomposed calcareous material, all forming a fairly compact deposit, 6ft. to 10ft. in thickness. extending (as proved by the workings) for considerable distances in various directions, and containing fairly large pockets of chrysocolla ((hydrous silicate of copper) and malachite ore. A large block of ground, 60ft. long N. and S. and 30ft. across, has been taken out between No. 1 and No. 2 adit, where stoping is now in progress, and from this section and other parts of the workings large quantities of fairly good ore were obtained, dressed, and sent to market. The last parcel of 14½ tons gave 15·7 per cent. copper. There are now about 8 tons of dressed ore on surface ready to send away. A sample taken from face of stope gave 9·1 per cent. copper ; one from a large boulder in N. drive, 4·1 per cent. ; one from a parcel of 8 tons dressed ore, 18·6 per cent. ; and one taken from No. 2 deposit (at foot of the hill), 8·6 per cent. (21–10–13.)

The Beltana Rapid Ore Treatment Mine (Copper Queen, *vide* Reviews Nos. 9, 10, 13, 14, 16, and 18).—Situated near Beltana.

The vertical shaft on the property is 6ft. x 4½ft. in the clear, and sunk to a depth of 72ft. For several months after the shaft was sunk to present depth an adequate supply of water was making, keeping the crushing and treatment plant working continuously; but for several months now the water has drained off considerably, and at present the amount of water making is not sufficient to keep the plant going one day a week, consequently very little work is carried on underground.

The shaft is in splendid order for continuing down. It has been closely timbered with closed sets of joggled and squared gum timber (8in. x 3in.) from surface to bottom. At the 60ft. level plats have been made and drives extended across the formation 20ft. each way from the plats. The lode matrix appears of considerable width, consisting of decomposed clay-slates impregnated with copper carbonates, and in places rich seams and bunches of malachite have been obtained, which are easily picked out and the lower-grade material is sent to the small three-head stamper battery, crushed fine, and is treated by the experimental rapid process plant on the mine, and one of the owners who is now in charge of the mine informed me that the present small experimental plant and the method of treatment have been very successful on the low-grade carbonate ore, and that he is quite confident that with a good supply of water and a larger plant he could make the treatment of that class of ore fairly remunerative.

A fair amount of work has been done at different points to shallow depths in the formation along the line of strike for a length of over 2 chains, and from the pits and open workings were extracted fair quantities of high percentage ore, which occurs in veins and pockets with lower-grade ore bearing material between. The formation appears very promising, and could be further tested at greater depth with the expenditure of a little capital to put down the vertical shaft deeper, and judging by the nature of the country, an ample supply of water will be obtained within the first 100ft. of sinking from present depth. (21–10–13.)

LOCALITY—EYRE PENINSULA.

Calcookra Copper Mine (*vide* Reviews Nos. 12 and 15).—Situated in the hundred of Hawker, 18 miles W. from Franklin Harbor.

Since my last visit a fair amount of good development work has been done. The main vertical shaft on the property has been sunk and strongly close timbered from the surface to a depth of 45ft. The inflow of water into the shaft is heavy, and cannot be kept down with the present windlass appliances, and to carry on deeper sinking it will be necessary to instal a winding plant and large kibbles or a pumping plant.

At a point about 60ft. E. from the old underlie shaft a small prospecting shaft has recently been sunk to a depth of 35ft., and at the bottom a drive in the lode has been carried in E. 10ft. The formation in the bottom, it is said, is 2ft. wide, containing a fairly rich vein of azurite, 3in. to 6in. thick. A sample taken from a parcel of ore on surface gave silver 16ozs. 4dwts., copper 22·4 per cent., and lead nil.

A short distance N. from the outcrop of the main lode a small prospecting shaft has been sunk to a depth of 23ft. in an ironstone formation which does not appear to contain any copper ore at that point. (8–12–13.)

Various claims comprising the Cowell Silver Find (*vide* Reviews Nos. 17 and 18).

Block No. 9467.—On this portion of the holding a large amount of prospecting work has recently been done. A large open pit has been made on the site where the rich ore was first discovered, and is carried down to a depth of 14ft. from surface. At that level drives 20ft. to 40ft. in length have been made in various directions. The country disclosed consists of decomposed limestone and schist, and appears

much faulted and disturbed. Small isolated patches of ore are said to have been obtained on the breaks (or fault walls), which are fairly defined and about 12ft. apart, and dipping S.W. at an angle of 50°.

About 400ft. further S. a tunnel has been started, and extended N. into the hill 60ft. This work of tunnelling when completed will prove the ground to a depth of 100ft. vertical below the workings on top of the hill.

N. from the above workings on blocks Nos. 9496 and 9497, Smith's shaft has been sunk to a depth of 34ft. A small formation was intersected in the shaft containing a seam of ore, 4in. to 6in. wide, of green and blue carbonates.

At the *Marowie* blocks, situated a short distance N. from last workings, a fair amount of development work has recently been done. The main shaft sunk on the property many years ago has been cleaned out, repaired, and securely timbered from surface to bottom, a depth of 137ft. The first 30ft. is vertical, and it appears quite likely that the underlie portion of the shaft was sunk in a branch of ore off the main body. It is now intended to carry down the vertical deeper and then put in crosscuts and drives to determine the width and extent of the ore body at greater depth.

Six samples taken from the different workings on the blocks gave on assay—

Sample No. 1, from S.W. drive 14ft. level, gave silver 10dwts., and lead nil.

Sample No. 2, from S.W. drive end of pit 14ft. level, gave 3ozs. 16dwts., and nil.

Sample No. 3, from hanging wall of pit 14ft. deep, gave 10dwts., and nil.

Sample No. 4, from Smith shaft, copper vein, surface dump, gave 2ozs. 12dwts.. and nil.

Sample No. 5, from Marowie shaft, picked sample, 40ft. level, gave 8dwts., and nil.

Sample No. 6, from tunnel workings, gave nil. (8–12–13.)

Elson Silver-lead Mine.—Situated in the hundred of Mann, 1 mile E. from Cleve township.

There are strong indications, at different points on the surface, of several formations and numerous gash-veins, varying in width from 3in. to 36in., of ferruginous quartz and ironstone ; the strike varying from N. to N.E. and E. in conformity with the country rocks.

The main workings are situated on top of Star Hill, 50ft. above the adjacent country and about 675ft. above sea level, and consist of two shafts. No. 1 shaft, which was started in the outcrop of the formation, is down to a depth of 12ft. The lode channel is about 2ft. wide, composed of broken siliceous gangue, containing small specks and veins of galena with silver and zinc for a width of from 3in. to 6in.

No. 2, situated 15ft. to 20ft. further E. and on the S. side of the outcrop, has been sunk to a depth of 32ft. At the 20ft. level a drive has been extended W. 5ft., the face of the drive is in disturbed broken country, which does not appear to contain much value at that point. A few feet more driving at this level should intersect the vein of ore showing in No. 1 pit, but now that the shaft has been sunk deeper it will be best to drive and prove the vein at the lowest level.

At the 32ft. level, the bottom of the present main shaft, a drive has been extended N. 10ft. and then 11ft. N.W., total 21ft. ; at a point in the drive between 8ft. and 12ft. in, a fault has occurred in the country bearing E. and W. with an angle of 60° S. The country N. of the fault is settled and of fairly hard nature. At 3ft. in N.W. from the fault a vein of schist 6in. wide, containing galena, is showing in the bottom of the drive. It appears a fairly promising make of ore and should be further tested by sinking a winze in it to see if the ore will make wider and is likely to continue down.

The drive now in 21ft. should be extended westward a further distance of from 15ft. to 20ft. to intersect the quartz lode showing on surface, and to prove if it contains any values at that depth.

The outcrop of the quartz lode in the vicinity of the shaft is traceable for a length of fully a chain, and although the ore on surface contains little or no values there are fair indications of a number of cross leaders likely to intersect the lode at different points that may cause the enrichment of the ore at depth ; however, that surmise can be more fully determined by extending the present drive through the lode and then drive on its course both ways, which would prove its extent and value, and the work done would doubtless be of great assistance in determining future operations on the property.

About 20 chains W. from the main workings the outcrop of a promising quartz reef is visible at different points bearing 10° S. of E., dip N. In one place a small hole has been sunk to a depth of 3ft., in which is exposed siliceous lode material and a ferruginous quartz vein 6in. to 8in. wide ; this vein appears a likely one to carry gold, and should be further tested at different points along the line of strike by cross trenches. There are also several other promising outcrops of lode formations visible at different places on the blocks worth a little prospecting work done to prove them. Thirteen samples of material were taken from the workings and other parts of the property and gave on assay :—

	Silver.	Lead. Per cent.
No. 1, taken from face of drive, 32ft. level, for a width of 3ft. gave	Trace	2·6
No. 2, taken from vein 6in. in bottom of drive, 32ft. level, for a width of 3ft. gave	1oz. 8dwts	12·7
No. 3, taken from across fault, 32ft. level, for a width of 4ft.	Nil	Nil
No. 4, taken from across ferruginous material, 32ft. level, for a width of 10ft. gave	Nil	Nil
No. 5, taken from boulder in face of drive, 20ft. level, gave	Nil	Nil
No. 6, taken from across face drive, 20ft. level, for width of 3ft.	Nil	Nil
No. 7, taken from ferruginous schist on surface, gave	Nil	Nil
No. 8, taken from outcrop 1 chain E. of shaft gave	Nil	Nil
No. 9, taken from outcrop 6 chains S. of shaft, gave	Nil	Nil
No. 10, taken from bottom of hole, 12ft. deep, 15ft. W. from shaft, for a width of 3ft., gave	0oz. 10dwts.	4·7
No. 11, picked sample from small dump of ore on surface	2ozs. 12dwts.	41·7
No. 12, quartz outcrop 20ft. N. of shaft, 4ft. wide	Nil	Nil
No. 13, quartz outcrop 20 chains W. from shaft, 6in. wide	Nil	Nil

(9–12–13.)